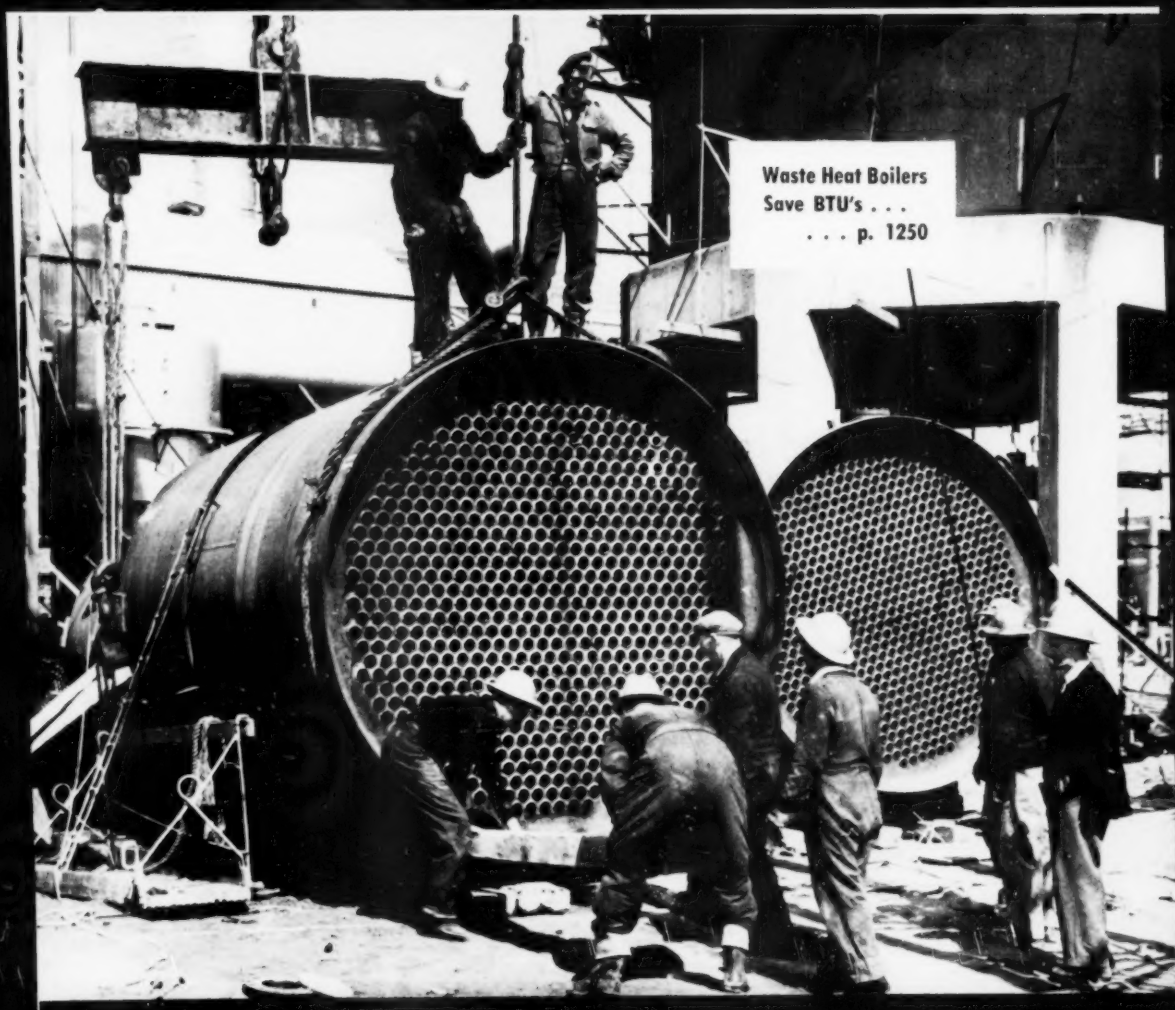
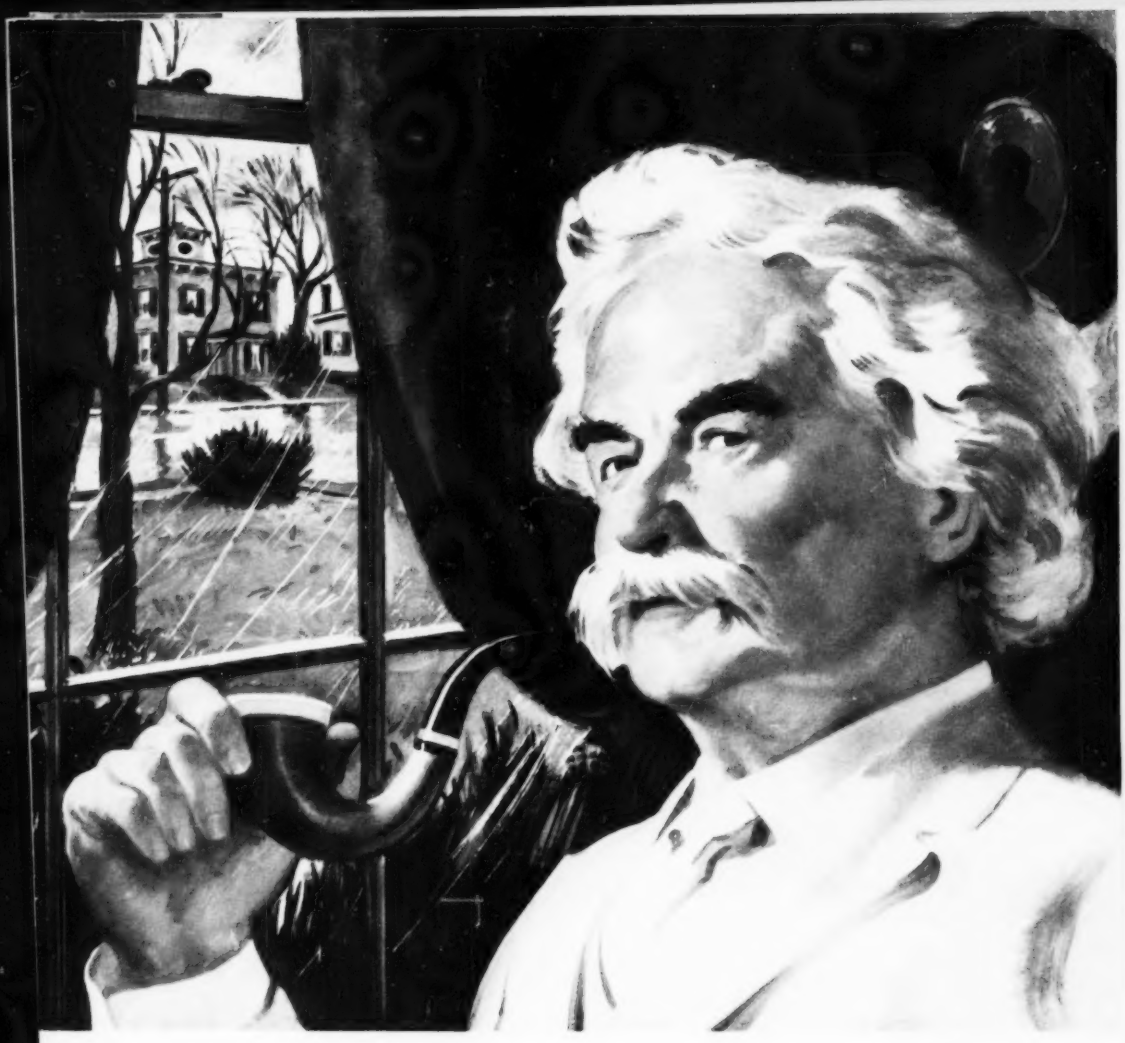
NOVEMBER, 1951
VOL. 6, NO. 11

PETROLEUM PROCESSING



HUDSON AIR-COOLED UNITS
Hudson Air-Cooled Units are now transferring more than 500,000,000 BTU per hour of process heat from STEAM, GAS, JACKET WATER, HOT OIL and HYDROCARBON VAPORS directly to the air, obviating the use of water as an intermediate transfer medium.
Gears, drive shafts, fans, finned tube surfaces and structural steel supporting framework which make up the Hudson Air-Cooled Units are selected and designed for long life in continuous outdoor service. Drivers may be electric motors, steam turbines, gas engines, or hydraulic motors.
Hudson Air-Cooled Units are manufactured and assembled in the recently completed Hudson plant at Houston. This practice minimizes field assembly costs. The Hudson organization welcomes the opportunity of studying your over-all heat dissipation problem. Such studies will enable you to make the most advantageous selections of cooling equipment for your particular problem, whether it be cooling towers with water-cooled units, or air-cooled units, or combinations of the two.
HUDSON
ENGINEERING CORPORATION
FAIRVIEW STATION HOUSTON, TEXAS
BATTERY OF TWELVE HUDSON AIR-COOLED UNITS IN A TEXAS PROCESSING PLANT.
COOLING—HOT OIL AND GAS
CONDENSING—STEAM AND HYDROCARBON VAPORS



You had something there, Mark Twain

We doubt if the beloved Mark Twain had gasoline refiners in mind when he was reported to have said:

"Everybody talks about the weather, but nobody does anything about it!"

But he certainly was hitting close to the problem which has for many years vexed refiners who wanted to obtain reliable road knock-ratings. There are hardly two days in a year when the same weather conditions are to be found . . . not to mention traffic variables. As a consequence, a day-to-day variation of four octane numbers was possible in the rating of a single fuel in a particular automobile. Fuel ratings obtained indoors on chassis dynamometers often were subject to considerable variation, and sometimes bore little relation to performance on the road. This is not surprising, because of differences in atmospheric temperature and humidity, and failure of the equipment in the chassis dynamometer room to provide "wind" equivalent to that encountered in normal car operation.

So Ethyl research people did something about it

They built two unusual chassis-dynamometer rooms in which atmospheric temperature and humidity can be closely controlled. Furthermore, air velocity against the front of the car

Continued on next page

ETHYL
ANTIKNOCK COMPOUND
ETHYL CORPORATION

You had something there, Mark Twain

Continued from preceding page

is automatically controlled relative to the speed of the rear tires. The two rooms constitute a flexible combination which can accommodate a wide range of automotive vehicles operated under substantially any combination of temperature, humidity and wind encountered in service.

A Real "Indoor Highway"

Simulation of vehicle operation on the road is further assured by equipment which causes the acceleration and speed of the rear wheels to be the same as those on the road resulting from any movement of the foot throttle.

Refiners who use Ethyl's all-weather rooms and accompanying fleet of modern cars in their research programs are now able to obtain . . . quickly and accurately . . . knockratings on current gasolines that duplicate what their customers would experience under actual road conditions. Long-range programs can be started with the assurance that the conditions of a test can be duplicated at any time in the future. Refiners whose gasoline is used under a variety of weather conditions can check its performance under any combination of conditions within the range likely to be encountered.

Other methods of evaluating fuel antiknock quality now used in the laboratory or on the road have value for control and demonstration purposes, and are employed in Ethyl's research and gasoline-testing laboratories. The advanced type of road knocktesting carried on in Ethyl's new all-weather rooms sets a new standard in the significant evaluation of gasoline antiknock quality . . . thus it becomes a most important service to refiners.

The next time you are in Detroit we shall be glad to show you these rooms. In the meanwhile, our descriptive brochure about them entitled "Road Knockratings Indoors with Ethyl's New All-Weather Rooms" is yours for the asking.

ETHYL CORPORATION

NEW YORK 17, N. Y.

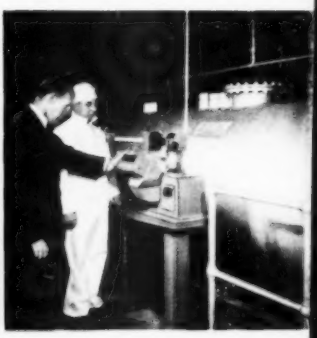
Ethyl service is backed by 28 years of antiknock experience

RESEARCH

SALES HELPS

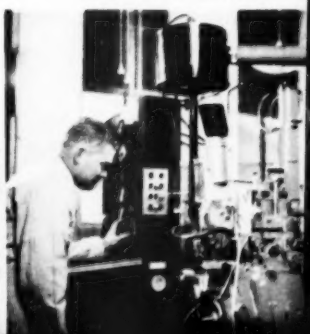
FARM SERVICE

ROAD TESTING

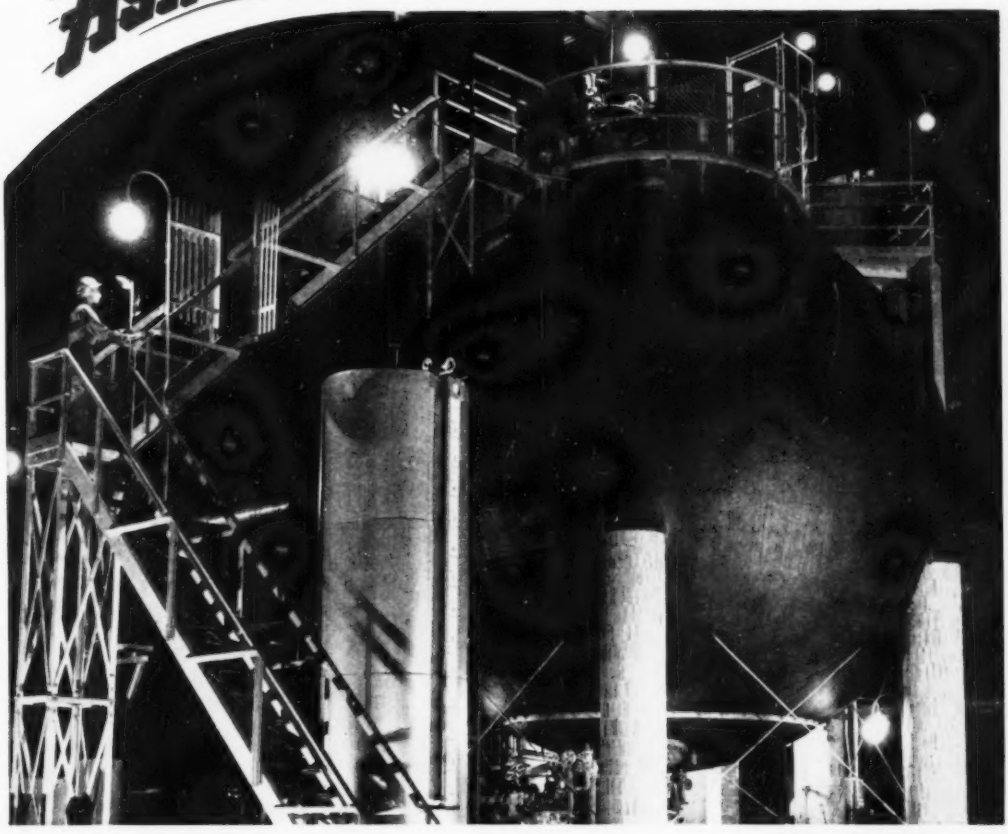


SAFETY SERVICE

GASOLINE TESTING



Ashland another leading refiner who desalts with PETRECO



The Ashland Oil and Refining Company and its affiliated companies are a fast growing and highly progressive organization. Like other leaders in the refining field, Ashland relies on Petreco Desalters to keep their crude charge free from harmful salts and solids. Like the many other experienced refiners who specify Petreco Desalting repeatedly, the Ashland group has installed Petreco in their refineries at Ashland, Kentucky; Canton, Ohio and Buffalo, New York.

Leading refiners such as the Ashland Oil and Refining Company have learned that Petreco Desalters consistently deliver high-efficiency performance, and are kept at this high performance level by helpful, dependable Petreco service engineers. **PETRECO OFFERS COMPLETE DESALTING SERVICE AND FACILITIES**

GET THE BEST IN DESALTING

Minimum residual salts and solids

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Maximum exchanger efficiency

Less corrosion in the topping section

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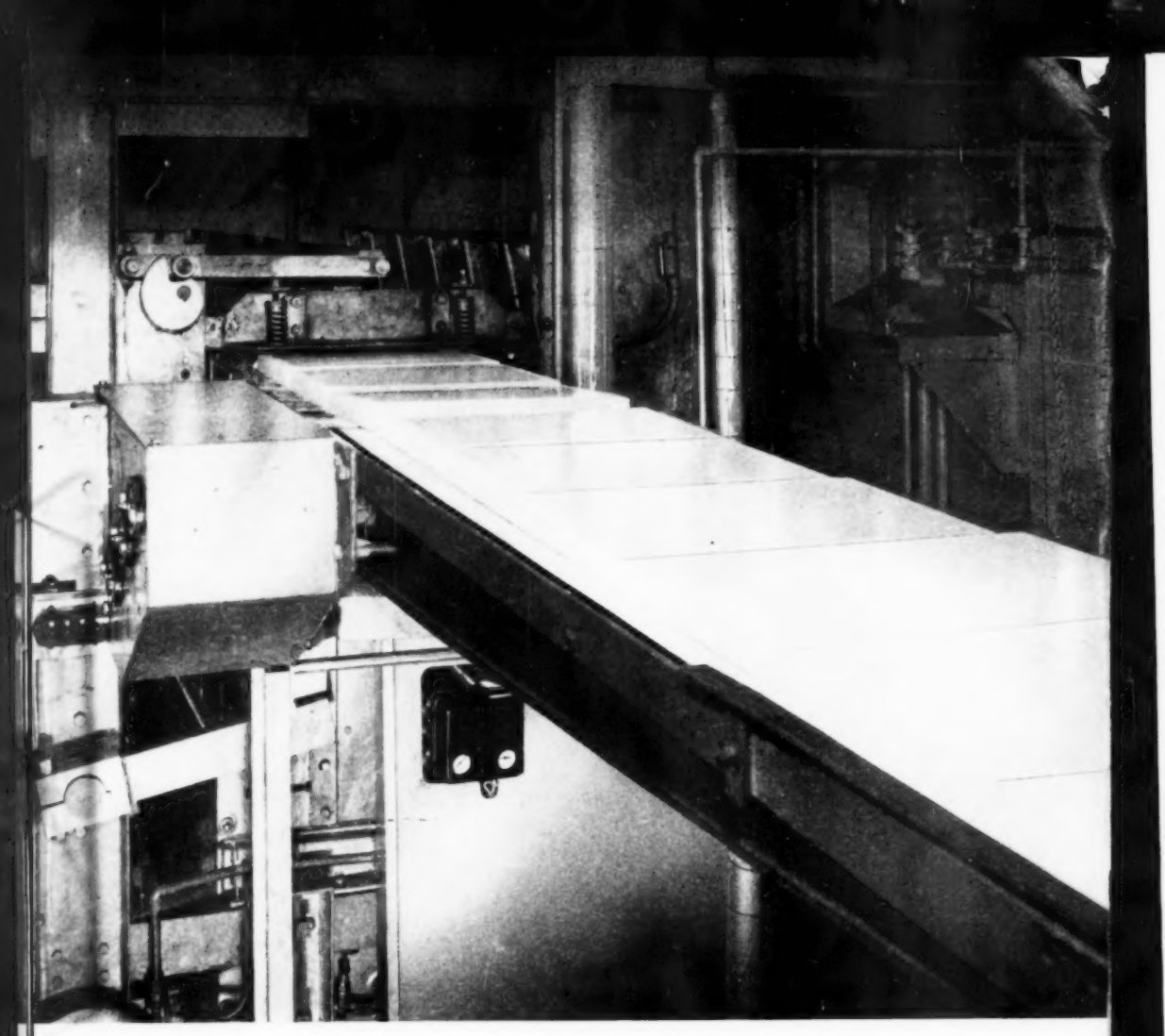
1390 E. Burnett Street, Long Beach 6, Calif.

PETRECO

SPECIALIZED *Electric* PETROLEUM PROCESSES { DESALTING / DEHYDRATING

PR 51-6



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Introducing Continuous Processing of Liquid Wax into Slabs

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Pictured above is the discharge end of the machine which occupies a space of only 19 x 78 feet — and produces 12,500 lbs. of finished slabs per hour — with a variation in weight of less than $\frac{1}{2}$ of 1%!

Developed and manufactured by the J. W. Greer Company, who for over 33 years have been solving problems of continuous automatic processing in the Biscuit, Cracker, Confectionery, and Process Industries.

For further information on this really NEW development, send for the bulletin containing specific data on capacities and technical specifications.

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PETROLEUM PROCESSING

Covering petroleum research and the design, management, operation and maintenance of plants processing hydrocarbon materials into fuels, lubricants and chemicals

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Published second Tuesday of each month by National Petroleum Publishing Co., 1213 West Third St., Cleveland 13, Ohio. Subscriptions: $8.00 a year in U.S. and possessions, $8.50 a year elsewhere. Single copies, 75 cents each; back copies more than three months old, $1.00 each. Microfilm copies available through University Microfilms, Ann Arbor, Mich. *Petroleum Processing* is indexed regularly in Industrial Arts Index, Engineering Index and Chemical Abstracts. Published prior to Sept., 1946, as the *Technical Section of National Petroleum News*, devoted to Refinery Management and Petroleum Chemical Technology, and including *International Petroleum Technology*. Trade mark registered U.S. Patent Office. Copyright 1951 by National Petroleum Publishing Co. Acceptance under the act of June 5, 1934, at Cleveland, Ohio, authorized Dec. 22, 1948.

Other Platt Petroleum Publications

Platt's Oilgram News and Platt's Oilgram Prices

A daily independent oil-news and oil-price reporting service issued from New York, Cleveland, Houston

National Petroleum News

The weekly oil marketing magazine, covering news prices, transportation, storage, merchandising

November, 1951
Vol. 6, No. 11

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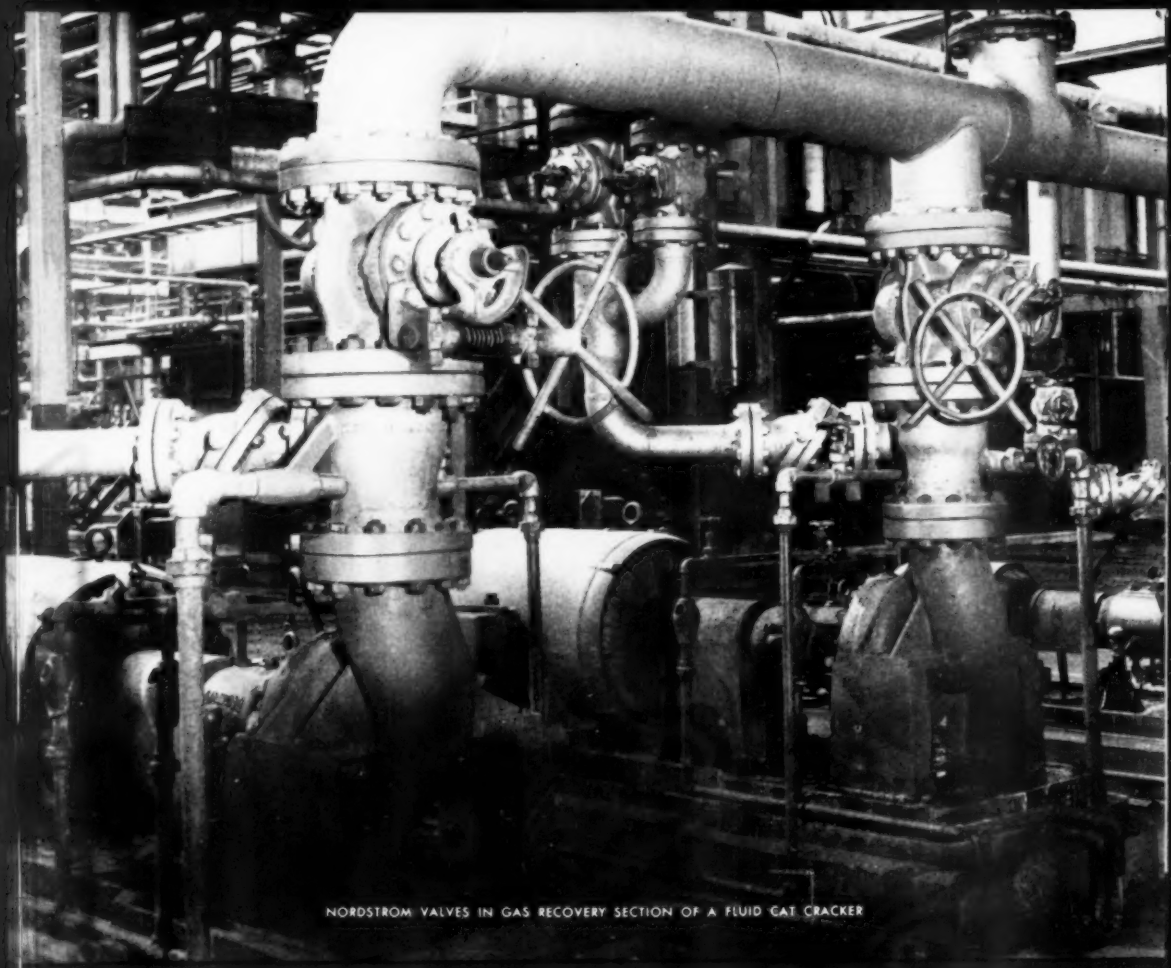
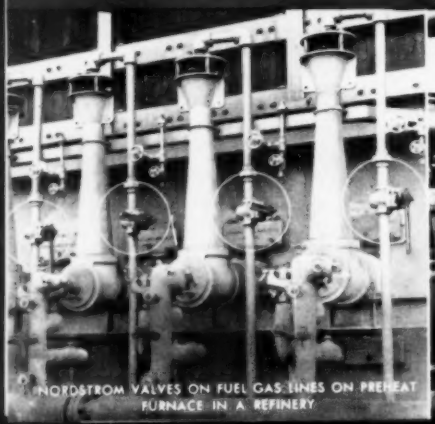
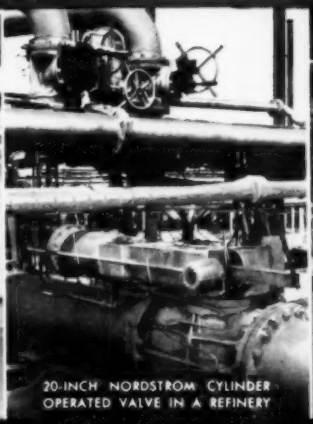


NORDSTROM VALVES IN GAS RECOVERY SECTION OF A FLUID CAT CRACKER

THE MOST *Saving*...



NORDSTROM VALVES ON FUEL GAS LINES ON PREHEAT FURNACE IN A REFINERY



20-INCH NORDSTROM CYLINDER OPERATED VALVE IN A REFINERY

RICH OIL LINE AND INTERCOOLER PUMPS EQUIPPED WITH NORDSTROMS

HOW TO SAVE 8 WAYS – WITH NORDSTROMS

1 **SAVE SHUTDOWNS**—Reduce flow line interruptions to a minimum. High resistance of Nordstrom valves to corrosion and erosion assures continuous operation.

2 **SAVE PRODUCT LOSSES**—*Tapered* plug with "Sealdport" lubrication insures against leaks.

3 **SAVE REPLACEMENTS**—Nordstrom valves guarantee longest life because seat is forever protected. Destructive abrasion does not occur at seat.

4 **SAVE OPERATING EFFORT**—A quarter-turn fully opens or closes a Nordstrom. No hammer-blow or seat forcing necessary. Plug can be hydraulically jacked if ever too tight.

5 **SAVE TIME**—You can close a Nordstrom in least time—moments against minutes. Power operated by hydraulic-pneumatic cylinder or electric motor if desired. Automatic lubrication with Hypermatic lubricant reduces maintenance to a minimum.

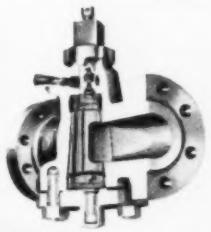
6 **SAVE SPACE**—Nordstroms do not require overhanging yokes. Least cubical dimensions. Can be set in line where space is at a premium.

7 **SAVE REPAIRS**—Positively the most enduring of all valves for chemical processing services as proved by records of low repair part costs over many years.

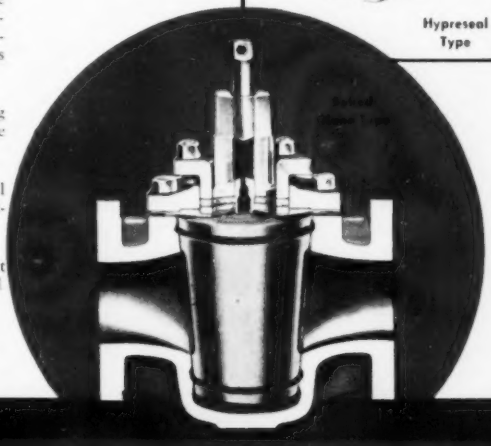
8 **SAVE PIPING**—You can install Nordstrom Multiport valves on your switching lines for 3 or 4-way control

AVAILABLE IN SEMI-STEEL, NORDCO STEEL AND SPECIAL ALLOYS

Screwed Gland Type



Hypreseal Type



...OF ALL REFINERY VALVES

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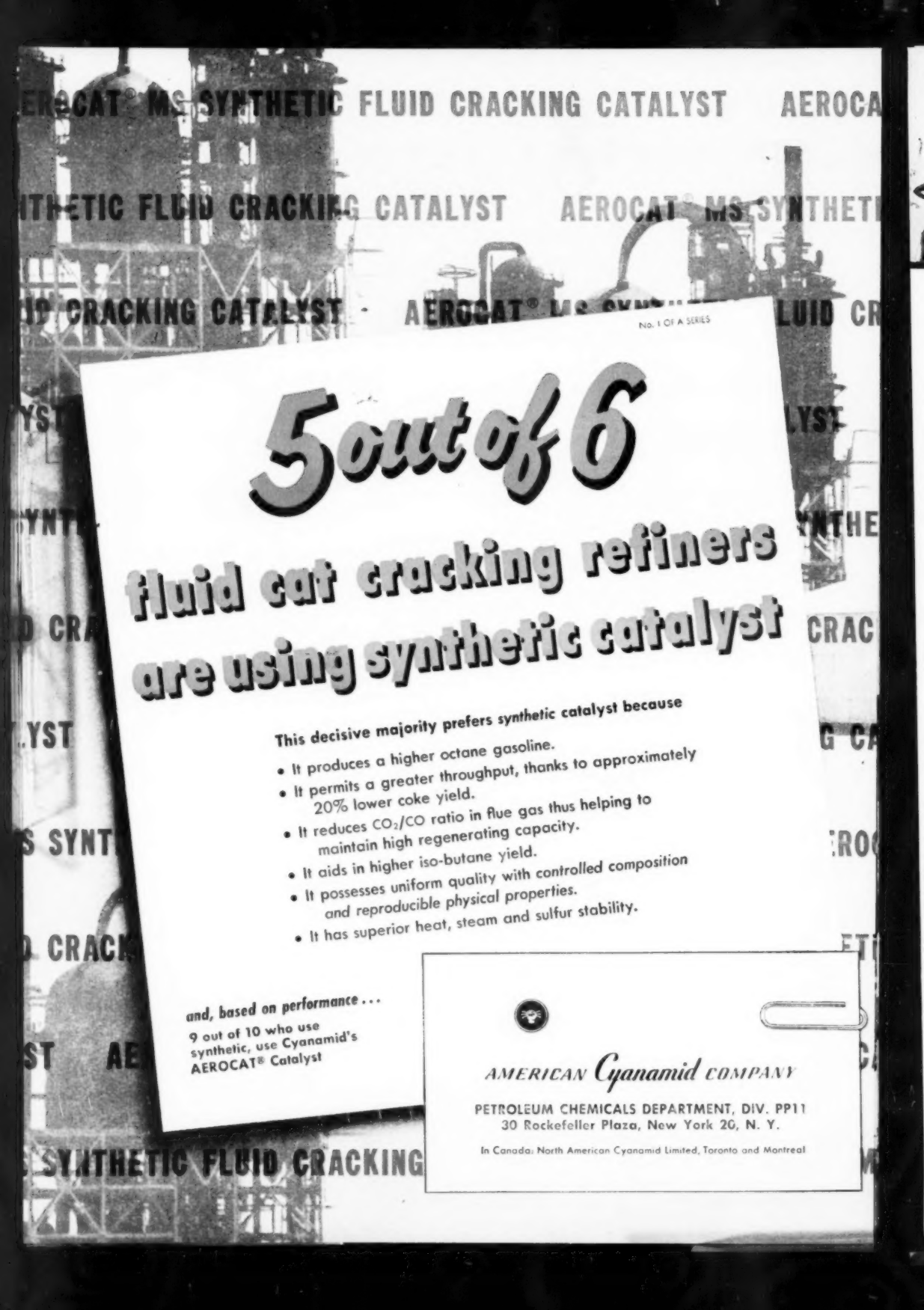
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No. 1 OF A SERIES
5 out of 6
fluid cat cracking refiners
are using synthetic catalyst
This decisive majority prefers synthetic catalyst because
• It produces a higher octane gasoline.
• It permits a greater throughput, thanks to approximately 20% lower coke yield.
• It reduces CO_2/CO ratio in flue gas thus helping to maintain high regenerating capacity.
• It aids in higher iso-butane yield.
• It possesses uniform quality with controlled composition and reproducible physical properties.
• It has superior heat, steam and sulfur stability.
and, based on performance . . .
9 out of 10 who use synthetic, use Cyanamid's AEROCAT® Catalyst
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WHAT'S HAPPENING

Current News Summarized For Oil Men

Expansion

Sinclair Refining Co. will increase capacity of its Houston refinery to 110,000 b/d from present 85,000 b/d, with completion in fall of 1953. Program will cost an estimated $28,000,000, and will include a new 40,000 b/d Fluid catalytic cracking unit and a 35,000 b/d crude unit. Primary contractors are C. F. Braun & Co. and Fluor Corp.

Gulf Oil Corp. has signed contracts for increasing capacity at Philadelphia from 107,000 b/d to 183,000 b/d (What's Happening, May 1951, p. 455). Construction will commence Nov. 1 on a 125,000 b/d atmospheric and vacuum topping unit, for which Foster Wheeler Corp. has contract, then a 63,000 b/d Fluid cracking unit. Also to be built is a 10,000 b/d catalytic reformer, 40,000 b/d gasoline treating unit, additional tankage and cooling facilities, new power plant, office building, refinery laboratory and other facilities.

Bay Petroleum Co. will increase crude capacity 5000 b/d at its Denver refinery to 11,000 b/d total and install a 3500 b/d Fluid catalytic cracking unit in a modernization and revamping program. For first time plant will be able to produce avgas components and high octane gasoline. Contracts have been signed with Procon and Universal Oil Products Co. for engineering and construction.

Esso Standard Oil Co. will spend more than $35 million to increase refining capacity at Baton Rouge from 240,000 b/d to 270,000 b/d, and expand local chemical operations. Program calls for a new two-stage pipe still, increased Fluid cracking facilities, additional equipment for processing petroleum gases into chemical base stocks and avgas components, and expanded blending and shipping facilities for gasoline, kerosine and heating oil. Benzene production increase also is scheduled, along with expansions in butadiene production and manufacture of synthetic alcohols.

Pure Oil Co. has announced plans to construct at its Nederland, Texas, refinery a new 20,000 b/d feed preparation unit, an Ortho-flow Fluid cracking unit of capacity in excess of 26,000 b/d, catalytic polymerization facilities and a substantial enlargement to the alkylation unit. Main portion of new units will be constructed by M. W. Kellogg Co.; completion date depends primarily on availability of materials. Last May DPA certified 75% of $11,140,000, covering catalytic cracking and alkylation units, as eligible for fast tax amortization.

Mercury Refining Co. has announced start of $3,195,000 construction program to increase its crude throughput from present 3150 b/d to 10,000 b/d. New facilities, which more than double existing plant investment, will include Fluid cracking, gas concentration, and catalytic polymerization and permit plant to produce aviation gasoline and jet engine fuel. As part of program, 565,000 bbls. of new storage will be added. Refinery Engineering Co., Tulsa, is contractor, with construction scheduled for completion before October, 1952.

Sinclair Refining Co. will install a 10,000 b/d SO_2 solvent extraction plant at its Wood River, Ill., refinery for the quality improvement of Diesel fuel and kerosine. Badger Process Division of Stone and Webster Engineering Corp. will build the plant.

COMPLETIONS: Aurora Gasoline Co., new 4500 b/d Platformer at Detroit refinery . . . **Shell Oil Co.,** additional facilities for manufacture of oil soluble sodium sulfonates at Martinez, Calif., refinery . . . **Gulf Oil Corp.,** new 60,000 b/d Fluid unit at Pt. Arthur . . . **Ashland Oil & Refining Co.,** first commercial installation (5000 b/d) of American Development Co.'s new electrolytic process for regenerating spent caustic, at Catlettsburg, Ky.

Petrochemicals

Gulf Oil Corp. will install a 60 long ton per day sulfur recovery unit at its Port Arthur refinery, utilizing hydrogen sulfide from refinery gases. The sulfur will be converted to sulfuric acid for the plant's alkylation facilities. Ralph M. Parsons Co., Los Angeles, is contractor. (More details on "Sulfur-from-Petroleum," this issue, p. 1248.)

Standard Oil Co. (Ind.) will expand by 45% capacity of its newly-completed benzene unit at the Whiting, Ind., refinery. Production will be increased from about 718 b/d to 1044 b/d. Completion is scheduled for the last half of 1952.

Shell Chemical Co. will construct facilities to recover in excess of 13,000 long tons per year of sulfur from refinery gases at its Houston plant, commenting that not only will unit recover scarce sulfur but will assist in eliminating air polution in the Houston area. Ralph M. Parsons Co., Los Angeles, is contractor; completion is scheduled for mid-1952. Sulfur will be sold for conversion to sulfuric acid.

National Petrochemicals Corp. has broken ground on a new $32,000,000 plant at Tuscola, Ill. Company was formed recently by National Distillers Products Corp. and Panhandle Eastern Pipe Line Co. Plant will recover ethane, LPG and natural gasoline from 500 million cu. ft. wet gas daily, supplied by Panhandle, converting 10 million cfd. of ethane to ethylene—

Information on these pages is obtained through the nation-wide news coverage service of PLATT'S OILGRAM NEWS

325 tons daily—and thence to ethyl alcohol, ethyl chloride, etc. LPG and gasoline will be distributed through regular trade channels.

Gulf Oil Corp. will start construction in December of a 20 long ton per day sulfur recovery unit at its Waddell, Texas, natural gasoline plant. Hydrogen sulfide tail gas from sweetening operations at the 38,000 Mcfd. plant heretofore has been burned. Project is scheduled for completion by February, 1952.

Standard Oil Co. of California has announced plans for the first synthetic phenol plant in the West, to cost approximately $4,000,000 and to be built at company's Richmond refinery. Plant will utilize a recently-developed synthesis process which uses neither sulfuric acid nor chlorine—both presently scarce materials.

Markets, Prices

October was a slow month for new business in most refinery districts, but more from a lull in orders than reduced requirements for refined oils. Distillates were amply stocked, waiting for cold weather and possible record-breaking demand. Military needs for the coming year appeared larger than for the current period. In addition, as long as the stalemate continued in Iran, a sizeable products deficit continued to roll up in U. S. export markets.

Prices at refineries were unchanged and generally firm, with few exceptions. In the Mid-Continent quotations for Grade 26-70 natural gasoline, at 6.875c, Group 3, and 6.375c, Breckenridge, were up 0.5c to the "ceilings" of most manufacturers. Prices for crude oil, lubricating oils, naphthas and solvents continued firm. Low viscosity solvent neutrals were quoted 1c lower in the Mid-Continent—24.5c for 180, and 25c for 200 viscosity. Wax prices were soft.

One of main supply developments was a shortening of the gap between demand and supply of heavy fuel in seaboard refining districts. This move was given an assist by large-scale shipments of No. 6 from the Mid-Continent to the Gulf, and also by a lingering maritime strike at New York that cut down ships' bunkering sales by an estimated 200,000 b/d. In Oklahoma, where a temporary surplus of heavy fuel caused some refiners to cut back operations, quotations for No. 6 were off 10c on the low to $1.65.

General abatement of retail gasoline price wars in New Jersey and eastern Pennsylvania was reported. At points where price cutting had been severe, wholesale tank wagon postings were up as much as 7.5c per gal.

Industrial Mobilization

Aviation quality blending agents cannot be used in any product except avgas, according to PAD Order 3 issued last month. The order also prohibits the use of any feed stock of suitable quality other than in the manufacture of a blending agent. Aviation quality blending agents are defined as alkylate, hydrocodimer and di-isopropyl; feed stocks as isobutane, butylene, propylene, pentylene or polymer, or any combination of these. PAD will grant exceptions in certain cases.

Minimum of 4 cc.'s of TEL is required in all commercial grade avgas used domestically, 4.6 cc.'s in that sold for export, according to PAD Order 4, also issued last month. Order is aimed at increasing total avgas supply by about 14,000 b/d.

Facilities for upping alkylate output by 31,000 b/d will be underwritten by the military. Armed Services Purchasing Agency has asked refiners to submit proposals for adding new units or rehabilitating old ones to that extent—with ASPPA agreeing to either purchase the product or reimburse the operator for keeping it in standby condition for a period of five years.

Refining industry's steel allotment for 1st quarter of 1952 will be 150,575 tons, according to breakdown of oil's cut of the steel pie released by PAD Oct. 30. This amount is nearly 40,000 tons more than 4th quarter allotment this year. Natural gas processing will get 50,875 tons.

Synthetic Fuels

Synthetic fuels were labeled "uneconomical" in report of National Petroleum Council's committee on the cost of such fuels, presented at Council's meeting Oct. 31. Based on detailed cost studies conducted over past year, committee said cost of producing a gallon of gasoline by coal hydrogenation would be 43.5c per gal. as compared with a present wholesale refinery price of gasoline of from 12 to 13c. Oil from shale came out better—with an estimated cost of 14.7c per gal., delivered to a major consuming area.

Immediate opposition to figures was voiced by Dr. W. C. Schroeder, chief of Bureau of Mines synthetic fuels branch. He offered figures of his own which indicated a cost of only 12c per gal. for gasoline from coal—10 to 11c for motor fuel from shale. One suggested reason for discrepancy was fact that Schroeder's figures include no allowance for recovery on capital investment, about 20c a gallon for coal.

Union Carbide & Carbon Co. has received a fast tax write off certification for a 300 ton/day experimental coal hydrogenation plant in West Virginia. Cost of project, which would produce benzene, light oils and toluene, is understood to be $11-million.

Miscellany

Phillips Petroleum Co. has won the 1951 Award for Chemical Engineering Achievement for its work in developing high abrasion carbon black and its contributions to cold rubber. The Award, sponsored by *Chemical Engineering* will be presented during Chemical Exposition in New York later this month.

Warren Petroleum Corp. will begin "at once" reconstruction of its fire-damaged Port Newark, N. J. liquefied petroleum gas terminal. Rebuilding program will cost $1.5 million and terminal is expected to be on full operation by year's end.

This IS THE *Fan*

COOLING TOWER WORKERS LIKE Because . . .

it operates day in and day out without trouble.

Cooling tower workers know that their reputation for steady, low-cost, efficient cooling tower operation goes up when Hartzell cooling tower fans go in. They know that this fan, even in the 22-foot size, has an amazing ability to withstand damage from vibration, abrasion, moisture, most acids and alkalies, salt and other deteriorating factors.

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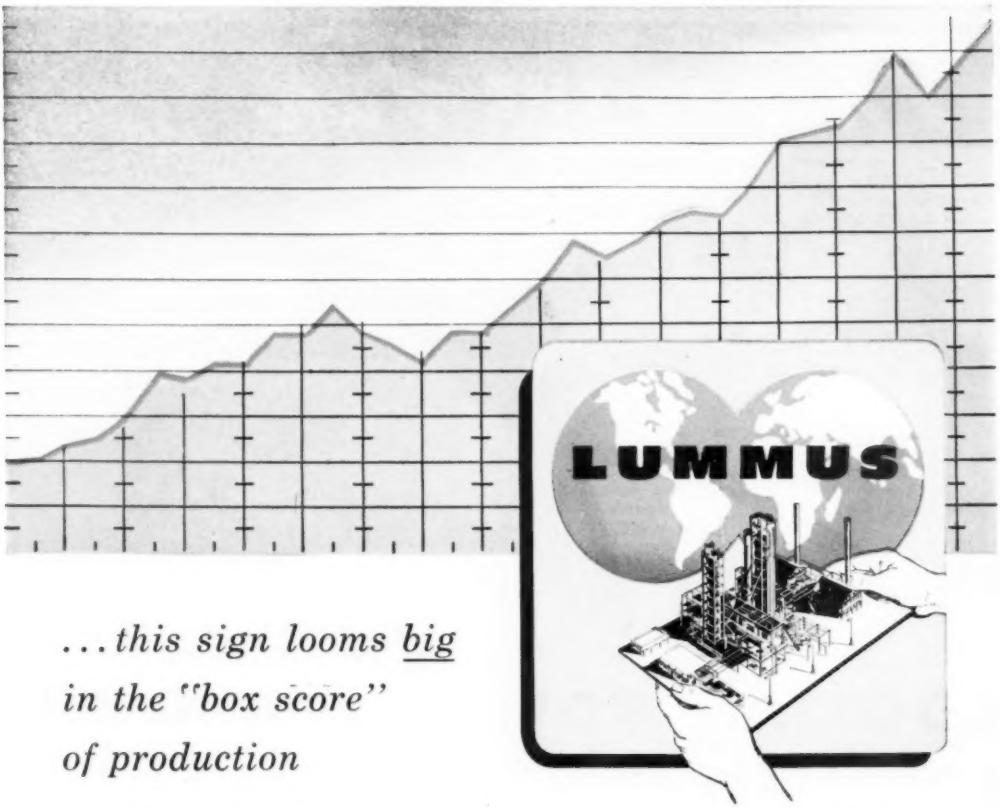

. . . this sign looms big in the "box score" of production

For better than sixty years the Lummus sign has meant *excellence* in the designing, engineering and constructing of petroleum refineries and chemical plants. It means the same today. And you need take only a short mental jump to see its importance in the days ahead, as oil refiners and chemical producers are called upon to break and re-break production records.

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Lummus currently has seven ethylene units "on the go" in Europe and the U. S.—plants which will operate with telling effect in supplying a vital basic raw material. One project—the Gulf Oil Corporation unit at Port Arthur, Texas—is the world's largest ethylene unit. It will produce nearly 2½ billion cubic feet yearly, increasing total U. S. production of ethylene by about 12%.

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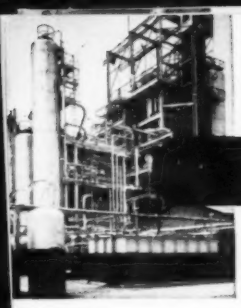

TOMORROW... IN PETROLEUM TECHNOLOGY

Possible Effects of Today's Developments On Future Operations

By the Editors of Petroleum Processing

Day When Coal Will Compete With Oil Seen Not Far Off

ONE authority in the coal industry holds very definite views as to the time when coal will become strongly competitive with oil. That day is not as far off as the oil industry has been accustomed to think, in his opinion.

In a statement prepared a few months ago for circulation only within the coal industry[1] Joseph Pursglove, Jr., vice president of Research & Development, Pittsburgh Consolidation Coal Co., cites several factors to back up his contention that "relatively, the new dawning for coal is just around the corner." Such great interest was shown in the report that the author provided PETROLEUM PROCESSING with a copy for discussion purposes.

Mr. Pursglove cites that petroleum production in the U. S. has increased 60% in the past 10 years and that natural gas consumption has increased $2\frac{1}{2}$ times in the same period, while present coal production is about the same as the average annual rate for the past 10 years. In terms of assured reserves of BTU's still remaining in the ground, coal represents about 96% of the total and petroleum and natural gas each 2%. "We are using up our scarcest mineral fuel reserves (oil and gas) at a faster and faster rate. It is only a matter of time until a reversal of some kind in this trend must take place. The $64 questions are what year or decade will the reversal occur, and will it be a gradual or sudden change?"

The nation is facing years ahead of world tension, the effect of which will be to expedite the time when coal will come back strongly competitive with other fuels, Mr. Pursglove brings out. "This period of tensions and/or wars will place increasing strains on our domestic reserves of oil and gas . . . If it's necessary to waste cheap gas to produce essential and higher-priced petroleum, the gas will be wasted. If increased withdrawals from certain oil pools are necessary to save the country, these withdrawals will be made even though the life of the pool is materially shortened. . . Furthermore, the demand for liquid and gaseous fuels during these periods increases by leaps and bounds, and they will be withdrawn from any present-day uses where coal can be substituted. We are already witnessing what one might call a small reversal in trends because many oil consumers are now transferring back to coal. This trend will continue and grow as long as the tension lasts, but it will not be a permanent trend until the day the big reversal arrives."

After 1955 Mr. Pursglove believes that coal, as such, will move into more and more situations now occupied by liquid fuels and natural gas. Under present semi-wartime conditions he sees residual fuel in such large demand for marine and other special purposes that it will not make further inroads on coal's markets. Even assuming a peacetime economy, residual fuel is seen as less and less a competitor of coal after 1955 because by then it will be more profitable for the refiner to upgrade it into other products.

"After coal has taken over those places where a simple substitution of fuels is possible, then it will be necessary to supplement naturally liquid and gaseous fuels by converting coal into these other forms of energy. This time is estimated by most oil people who have made such predictions to be between 1957 and 1960. It might be sooner depending on world conditions."

It is interesting to note that the observations in the report were made before the crisis developed in the Iranian oil fields, the current situation strengthening the point as to the competition of foreign oil in the U. S.

What is overlooked in the general presentation is the possibility of large new reserves of oil or natural gas, or both, being discovered in the U. S. which might push further into the future the day when coal will take over oil's markets. However, in the face of the present growing oil consumption, it would take large reserves indeed to affect the supply-demand trend materially. —V.B.G.

(1) "A Discussion of Coal's Possibilities in the Next Ten Years", report to the Sales Division, Pittsburgh Consolidation Coal Co., by Joseph Pursglove, Jr., Vice President Research & Development.

Expanding Uses for Petrochemicals Predicted for Next Ten Years

ABUNDANT supplies of raw materials, fast-growing use of end products, and technological progress in processing, have combined to make the manufacture of petrochemicals an important phase of petroleum refining today, with even greater developments indicated for the next decade.

The total volume of aliphatic chemicals produced in the U. S. now is nearly 16,000,000,000 lbs. annually, "and it can be estimated that a good 75% of this present output is derived from petroleum and natural gas, although the 1925 share from these same sources was under 1%. The aliphatics have long since overtaken and surpassed the cyclic chemicals, which amount to scarcely more than half as large a volume today."[1]

The petroleum aromatics industry entered the field of aromatic chemicals production largely because of the unprecedented demand for toluene in the last war, and refiners now are the major suppliers of toluene and xylenes.[2] Today, operations in the field of aromatic production have been diversified until a variety of products is offered. The current benzene shortage presents a new challenge to refiners in this field. It is estimated that a shortage of 30,000,000 gals. will exist in 1951 and may increase to 100,000,000 gals. a year within five years. Benzene produced at petroleum refineries at present is by the dehydrogenation of cyclohexane.

A large amount of work is reported on the development of a process to produce benzene from normal hexane by combined cyclization and dehydrogenation, and announcement has been made of a process in the laboratory stage for the aromatization of normal hexane. Commercial application of these or similar processes would be of great help in relieving the benzene shortage.

"Paramount among the outlets for petroleum raw materials outside the field of fuels and lubricants are the elastomers and plastics."[3] It is expected that synthetic rubber production in 1951 will exceed 800,000 long tons (1,800,000,000 lbs.) and that during the same period nearly 2,000,000,000 lbs. of plastics will be produced."

The most versatile starting material presently derived from petroleum for the production of polymeric products is ethylene. This gaseous hydrocarbon is produced in large volumes in cracking processes and is recovered from refinery gases for direct polymerization or for conversion to other polymerizable monomers. Production of ethylene for use in chemical processes has increased four-fold in the past 10 years.

A significant trend is the production from petroleum feed stocks of acetylene as a chemical intermediate. Acetylene is a starting material for the commercial production of chloroprene, vinyl chloride, vinyl acetate, acetic anhydride and acrylonitrile. Development work has reached the point that several concerns are reported to have plans under way for large scale commercial production of acetylene from petroleum feed stocks, some of which is to be used directly for the manufacture of acrylonitrile.

"There is every indication that the next several years will witness a rapid increase in the use of petroleum raw materials in the production of elastomers and plastics, and that the petroleum companies will become increasingly active not only in providing the starting materials but also in operating the chemical processes of converting them."

(1) "Aliphatic Chemicals." O. A. Colten and A. Jonnard, Shell Chemical Corp. Presented before ACS, New York, Sept. 6-7, 1951.
(2) "Aromatics from Petroleum". Robert M. Love and Reuben F. Pfenning, Humble Oil & Refining Co. Presented before ACS, New York, Sept. 6-7, 1951.
(3) "Elastomers and Plastics". W. B. Reynolds and W. W. Crouch, Phillips Petroleum Co. Presented before ACS, New York, Sept. 6-7, 1951.
(4) "Synthetic Detergents from Petroleum". W. K. Griesinger and J. A. Nevison, Atlantic Refining Co. Presented before ACS, New York, Sept. 6-7, 1951.

Three Possibilities for Improving Utility of TEL in Motor Fuels

DESPITE the increases which have occurred in base fuel quality, the point of diminishing returns in the antiknock effectiveness of tetraethyl lead has in nowise been reached.[1] Available data show that the percentage increase in performance number due to TEL is generally the same in high antiknock hydrocarbons as in low antiknock hydrocarbons of the same chemical type. "Hence the actual increase in the value of tetraethyl lead is greater at high antiknock levels, as a greater actual rise in performance number is obtained."

Among the possibilities for further improvement in the utility of tetraethyl lead in motor gasolines at high antiknock levels are at least three: (1) development of still "milder" engines for best use of sensitive fuels with TEL; (2) discovery of economic means for reducing the sulfur in gasolines to very low levels, or of otherwise minimizing its deleterious effect on TEL; (3) production of base gasolines which, blended with TEL, will give higher road antiknock values than indicated by conventional laboratory test methods.

With regard to the second possibility, it is stated that, while the different types of sulfur compounds show varying degrees of TEL destruction, "all have a deleterious effect, and as much as two-thirds of the effectiveness of tetraethyl lead may be lost in a gasoline high in sulfur."

(1) "Tetraethyl Lead". Graham Edgar, Ethyl Corp. Presented before ACS, New York, Sept. 6-7, 1951.

More Use of Sour Crudes Requires Newer Methods of Desulfurization

THE greater utilization of crudes with a sulfur content of 1% or higher, the introduction of more complicated refining processes, and the more favorable economic position sulfur is achieving in the world chemical markets will give impetus to refiners' search for new methods for sulfur removal and recovery. (1)

Table 1 shows the geographical distribution of sulfur in the world's crude petroleum production and its tonnages in present production, showing the high potential availability of this chemical from this source. Of existing methods, some form of hydrocatalytic process is said to offer possibilities for the greatest degree of desulfurization and achieving the highest sulfur recovery. Hydrocatalytic desulfurization has been available for many years as a technical process. Its advantages are a high yield and elimination of sulfur as hydrogen sulfide. Full-scale application has been retarded by the high cost of hydrogen. As regards the future, however, it is stated: "Such processes will probably be examined in great detail with the hope that the more favorable product distributions resulting from hydrogenation will at least partially offset the high hydrogen cost."

It is in the field of middle distillates and fuel oils that sulfur may confront some refiners with major problems that will grow as the production of high sulfur crudes continues. Many companies are studying methods for the desulfurization of high-speed Diesel fuels. Of the methods on which information is available, the most attractive seem to be sulfur dioxide and furfural extraction, "the latter having merit because it has successfully handled high sulfur catalytic cracked recycle stocks."

(1) "Desulfurization and Sweetening". Thomas Tate, Research Station, Anglo-Iranian Oil Co., Ltd., Sunbury-on-Thames, Middlesex, England. Presented before ACS, New York, Sept. 6-7, 1951.

TABLE 1—Distribution of Sulfur in World's Crude Oil on a Geographical Basis

(From data in the paper "Desulfurization and Sweetening")

Area	Approx. Prod. 1000 b/d	Avg. Sulfur Content % Wt.	Millions Long Tons Per Year
North America, including U. S. Mexico and Canada	5,270	1.0	2.6
South America, including Trinidad	1,570	1.8	1.4
Near and Middle East, including Persia, Saudi Arabia, Kuwait Iraq, Bahrein and Egypt	1,430	1.6	1.1
U.S.S.R. and Eastern Europe	810	<0.4	0.2
Far East, India, Pakistan, Burma	200	<0.2	<0.1
Western Europe	30	<1.0	<0.1
TOTALS	9,310		5.3

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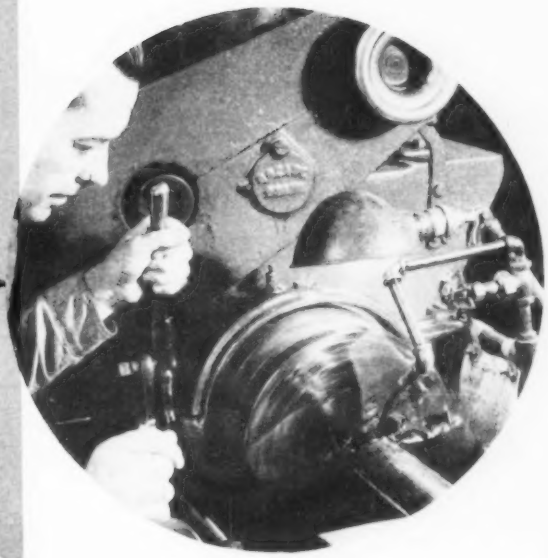

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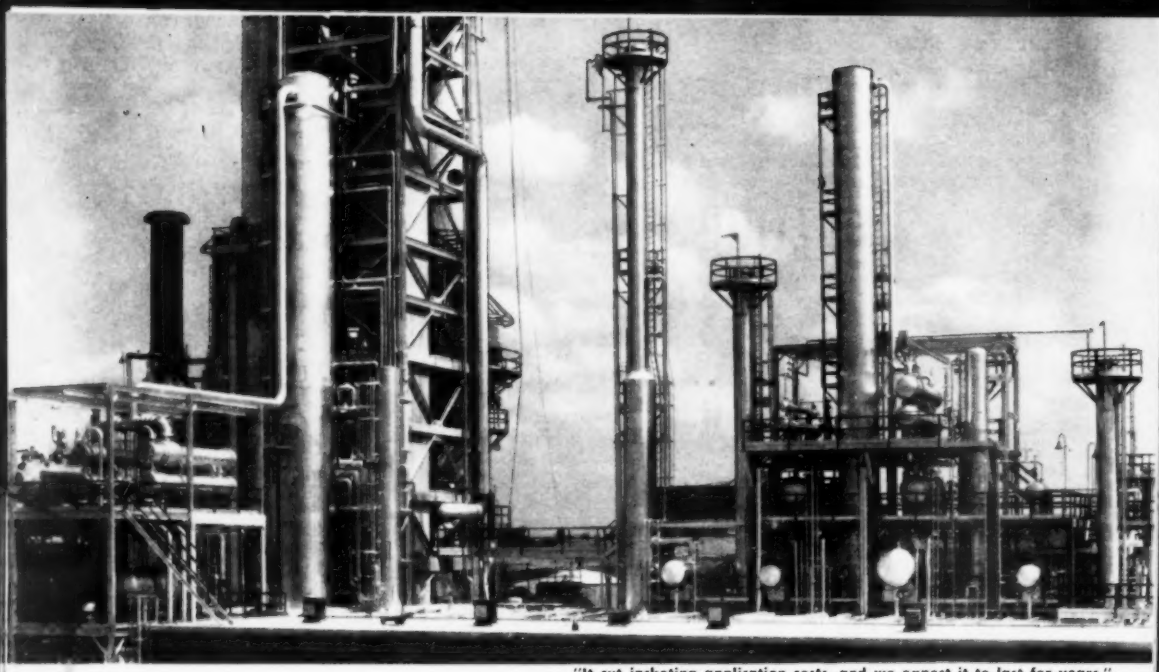
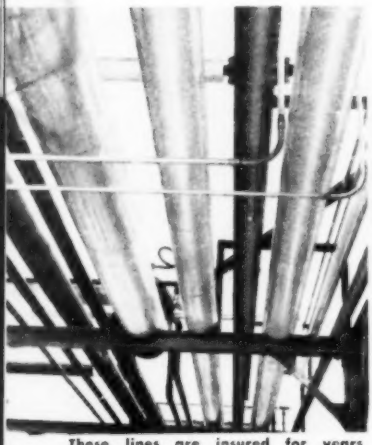


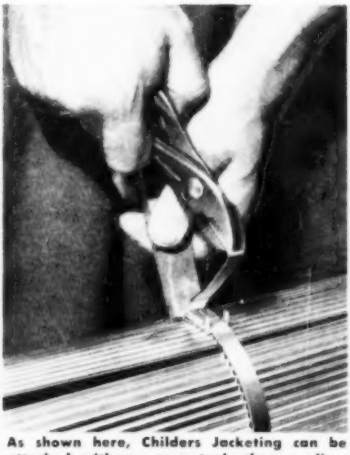
"It cut jacketing application costs, and we expect it to last for years," report engineers at refineries everywhere after testing Childers Aluminum Jacketing on their insulated lines. This new Oklahoma refinery used Childers 100% — on towers and vessels (in heavy weight) as well as on lines. It is flexible and easy to put on, and this 3S alloy aluminum is tough and weather-resistant, even in corrosive industrial atmospheres. This is the first and only jacketing especially engineered for process plants and power installations.

Refineries cut maintenance on insulated lines by switch to new low-cost aluminum jacketing

At least 567 processing plants have installed and tested this new Childers Aluminum Weatherproof Jacketing during the last three years. You can examine its advantages for your plant by writing for a free sample. Address Childers Manufacturing Co., Dept. TR-3, 625 Yale St., Houston 7, Texas.



These lines are insured for years against wear and weather. They'll never need painting because Childers Jacketing gives them all the advantages of appearance and long life that come only with weather-resistant aluminum. Yet this specially engineered jacketing costs far less than would heavy aluminum sheets.



As shown here, Childers Jacketing can be attached with no more tools than a pliers and a wooden wedge. No expensive shop work or pre-forming are necessary. Several methods of attaching are available, but aluminum bands shown here are probably best and cheapest. Because this jacketing is so easy to handle and so simple to attach, it cuts installation costs way down.

This is how the flexible, easy-to-handle Childers Jacketing arrives at the job site. It is in convenient rolls 4 feet wide and 100 feet long—just right for one man to handle—and is available either with or without a moisture barrier attached on the back of the .006" aluminum "skin". It can be cut to proper lengths using any flat table and a straight-edge.

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LETTERS

Tank Farm Fire

I am very much interested in your publication of Jim Hill's report on the Union Oil Co.'s recent tank fire ["Five Fire Protection Lessons Proved by Tank Farm Blaze," Oct. PETROLEUM PROCESSING, p. 1112]. Jim has done an outstanding job in preparing data and pictures of the fire, and the petroleum industry can profit from the experiences taught by it.

In addition to the five items covering good engineering practices in tank field construction, I would add "minimum spacing of one tank diameter and locating pipe alleys outside of tank dike areas" to the list.

One very interesting example brought out by this fire is that even when a number of large oil tanks are involved in a fire, the fire can be controlled and extinguished within the refinery area. . .

R. T. HENDERSON
Chief Safety Engineer

Standard Oil Co. (Ohio)
Cleveland, Ohio

● Your article on Union Oil's tank fire should be corrected on p. 1114 as follows:

"A total of 496,800 lbs. of '2-in-1' and 'A' and 'B' chemical foam powder was accumulated during the fire. Of this, 373,000 lbs. were used within the dikes east of tanks 279 and 280, to confine the ground fires to small areas where 3-dimensional fires burned from fuel sprayed from damaged Victaulic couplings and leaking flange gas jets. Most of the powder was consumed during the first 18 hrs. when the fire near Diesel Tank 293 was burning at its greatest intensity. The refinery foam powder supply of 143,750 lbs. was augmented by 292,700 lbs. borrowed from neighboring refineries and Union's Pipe Line Department stocks, plus 60,350 lbs. purchased during the fire."

Some people have asked us if Tank 100 could not have ruptured because of the butane vapor pressure exceeding the venting capacity of this tank and the ignition have been caused by high-energy mechanical sparks coincident with the roof failure. We are sure this was not the cause based upon prior studies of the operations.

JAMES E. HILL
Training and Safety Supervisor

Union Oil Co. of California
Los Angeles, Calif.

● . . . I wish to salute the Union Oil Co. of California for permitting this exclusive story to be written. Speaking for the industry, it has done a twofold job:

1. It has provoked much comment within our company and the lessons it so ably illustrates will certainly shape plant design of the future and

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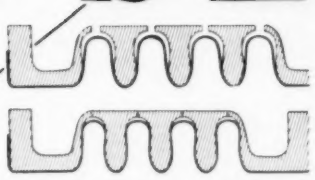

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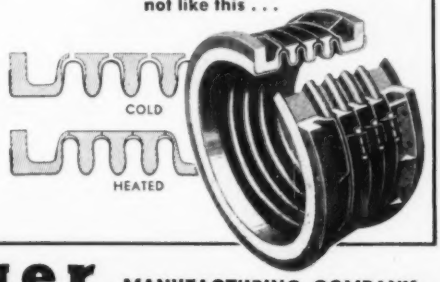

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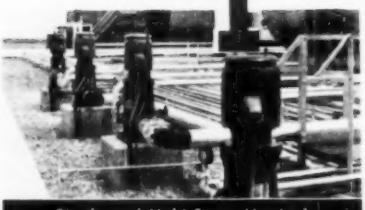
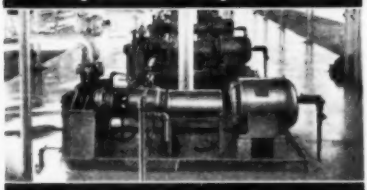
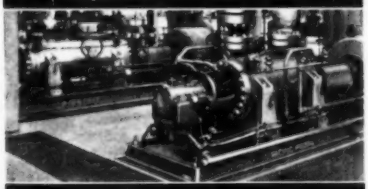


Single and Multi Stage Vertical



Single and Two Stage Process



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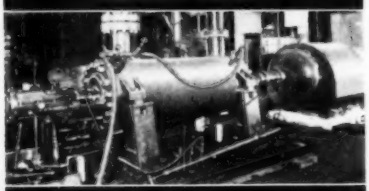

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Letters

initiate a survey of present equipment located in strategic areas.

2. We like the frankness of the Union Oil Co. of California in openly discussing this unfortunate occurrence. If, in so doing, they have established a precedent, it is a good one.

Let's hope that industry-wise all companies will follow the leader and in so doing help to reduce to a measurable degree such occurrences in the future.

ALFRED E. BACCINI
Technical Consultant

Atlantic Refining Co.
Philadelphia, Pa.

● . . . I believe [the findings outlined in the story] are sound and I do not question the assumption that ignition was caused by static electricity. The introduction of butane into the very bottom of the tank with a 3-in. water bottom present constitutes one of the best generators of static electricity known. All that is needed for a fire is the presence of a flammable vapor mixture and the results are pretty good proof that such a mixture was present.

The discussion concerning proper failure of tank roofs at the eave angle and the cautions against the use of cast iron fittings are in line with good practice. . . .

C. H. BUNN, JR.
Esso Engineering Dept.

Standard Oil Development Co.
Linden, N. J.

● You really have a good story and one of the type that industry can profit by. . . .

One point that is most frequently overlooked or covered lightly is the *source of ignition*. Here is the key to most fires and the point at which prevention work can begin. To my mind the details at which prevention work can begin of the extent and dimensions of the fire may be spectacular, but they are not nearly as important as the ignition.

I realize that in most cases the *exact* ignition cannot be definitely identified but . . . there has to be this ignition and a discussion of possible sources and evidence of such should be developed.

. . . I find that I cannot agree with all the conclusions drawn as they have overlooked such items as bonding, grounding, bottom inlets with no-spray nozzles, etc. Personally, I think butane and gasoline CAN be safely blended in tanks. I think there is a safer piping arrangement to tank batteries than ditch headers.

The real value of your article is that it makes petroleum companies THINK of safety.

DON ATTAWAY
Safety Engineer

Arkansas Fuel Oil Co.
Shreveport, La.

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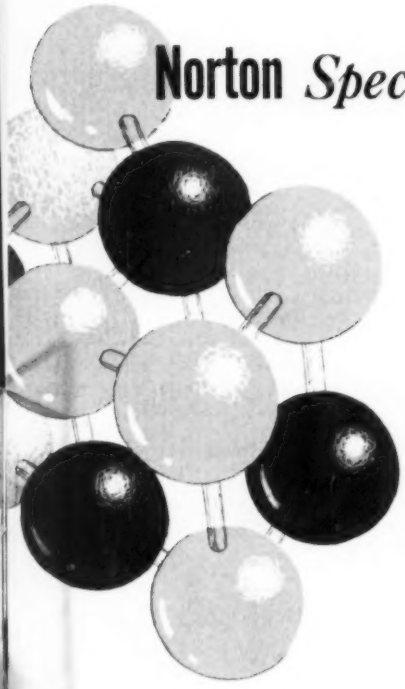

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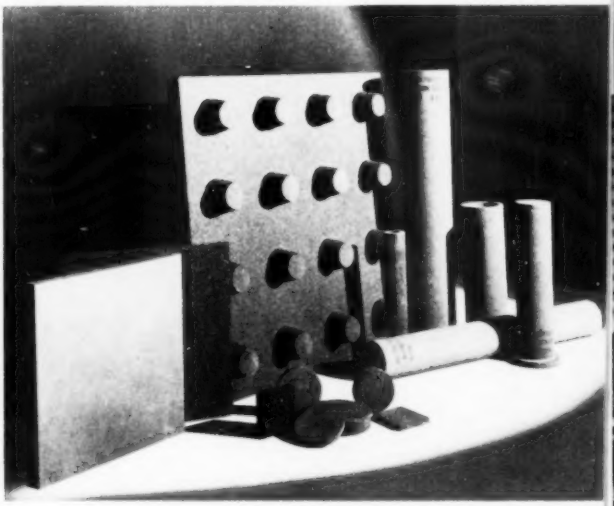
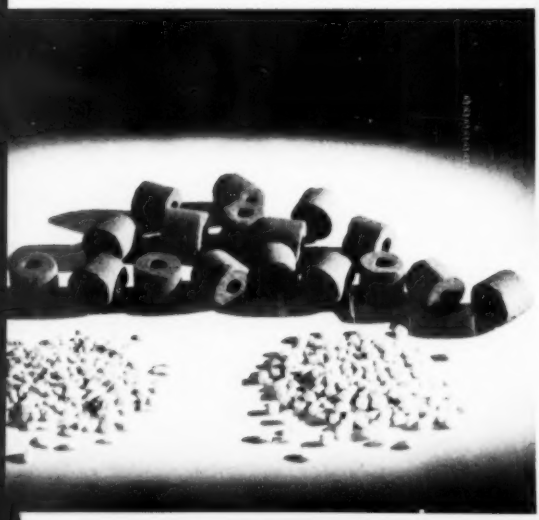
For 40 years, Norton research has pioneered in the development of special refractories for high temperature applications that are complicated by chemical, electrical, and physical variables.

Working with many electric furnace products, Norton Research has created a wide variety of special refractories having properties of great value for the chemical industry. These are CRYSTOLON* (silicon carbide), ALUNDUM* (fused alumina), MAGNORITE* (fused magnesia), and FUSED STABILIZED ZIRCONIA. A few of these products are discussed here. For more complete information call your nearby Norton refractories engineer, or write Norton Company, Refractories Division, Worcester 6, Mass.

1. NORTON ALUNDUM CATALYST SUPPORTS are designed to give you the surface areas you require for such applications as the manufacture of phthalic anhydride, production of ammonia, and reforming of natural gas. They are made in spheres, rings, and pellets of various sizes with controlled external and internal structures suitable for coating or impregnating. Their chemical stability and purity assure end products free from contamination. More important, the supports are free from chemicals which "poison" the catalyst. Their high refractoriness and resistance to abrasion insure long life. Norton catalyst supports can also be made from MAGNORITE, FUSED STABILIZED ZIRCONIA, CRYSTOLON, and MULLITE as required.



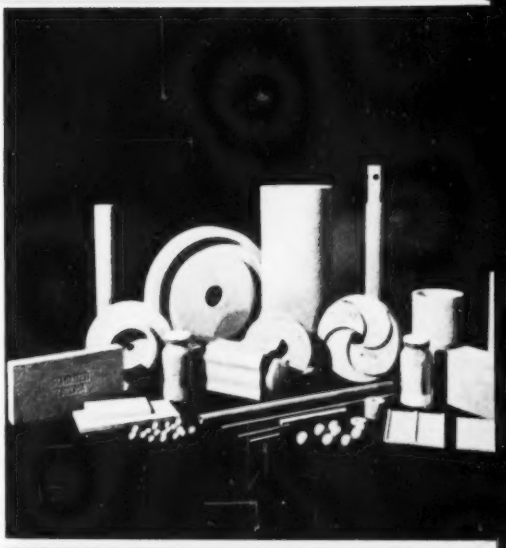


2. NORTON ALUNDUM POROUS MEDIUMS are made in a wide range of sizes and shapes in plates, tubes, discs, and diaphragms for filtration, diffusion, aeration, and electro-chemical applications. Uniformly porous because of patented controlled structure, ALUNDUM porous mediums for all practical purposes are unaffected by the acid, or alkaline conditions normally encountered in commercial applications. Their great strength and extreme resistance to abrasion combine to give them extra long life. Their ability to resist properly applied temperatures up to 1850° F. enables you to burn off organic matter if it clogs the pores.

3. NORTON REFRACTORY SHAPES FOR REACTION FURNACES include bricks, plates, tubes, and blocks in a wide variety of designs. CRYSTOLON, ALUNDUM, MAGNORITE, and FUSED STABILIZED ZIRCONIA refractories are used, depending on the temperature, chemical, electrical, and physical variables.

More and more firms are becoming interested in Norton FUSED STABILIZED ZIRCONIA for obvious reasons. No other refractory is so chemically stable at such elevated temperatures. For example, the chemical industry has operated gas synthesis processes in Norton FUSED STABILIZED ZIRCONIA lined furnaces for long periods of time at temperatures approaching 4700° F. in a neutral to slightly reducing atmosphere.

In addition to its exceptionally high melting point and great chemical stability, Norton FUSED STABILIZED ZIRCONIA has exceptionally low thermal conductivity. This means lower heat loss and resultant lower operating costs even at temperatures up to 4700° F.

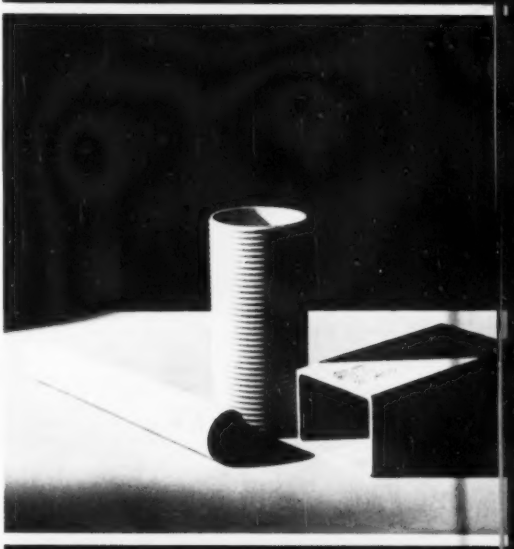


4. NORTON REFRACTORY SHAPES FOR ELECTRIC FURNACES include cores, tubes, and muffles made of ALUNDUM and CRYSTOLON refractories.

Where chemical stability and inertness are required, Norton ALUNDUM shapes are first choice. They do not react either with metallic resistors or with platinum, nickel or fused oxide laboratory ware.

Where high thermal conductivity and resistance to heat shock are necessary, Norton CRYSTOLON shapes offer advantages over ALUNDUM shapes. They are limited however to resistors of nickel chromium alloys and to temperatures not exceeding 2100° F.

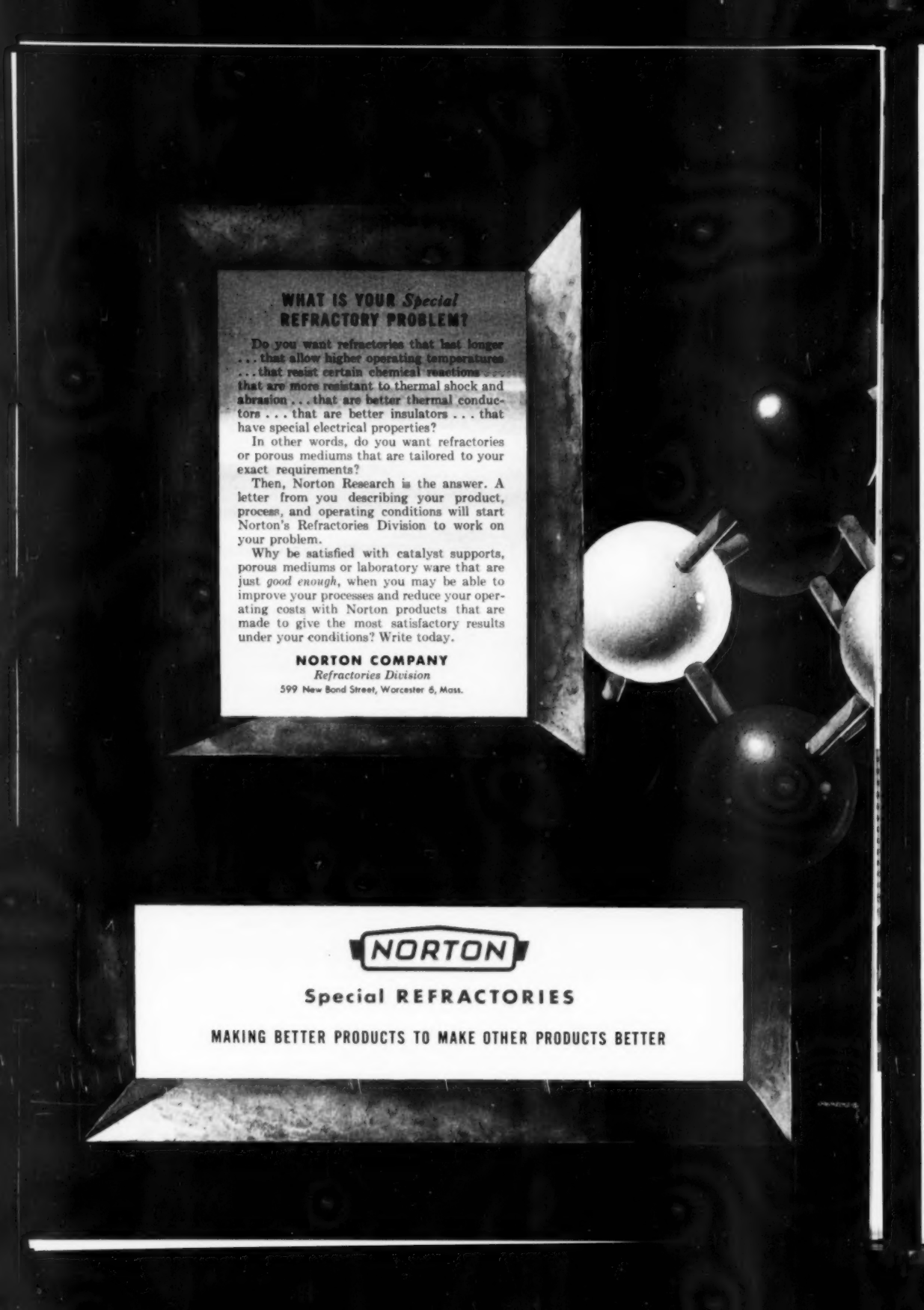
Tests with resistors made of Norton FUSED STABILIZED ZIRCONIA in both ultra high frequency induction furnaces and in resistance furnaces indicate possibilities well worth your investigation.

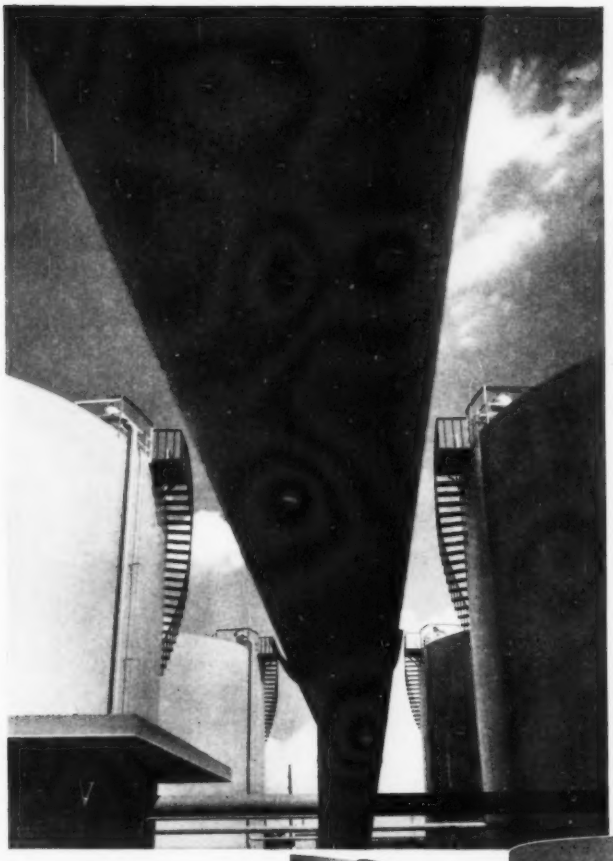


5. NORTON ALUNDUM LABORATORY WARE, containing at least 85% alumina (up to 99% in special mixtures) is not attacked by any organic solvent. Only hydrofluoric acid, concentrated phosphoric acid or concentrated alkalies can affect it. Its maximum usable temperature ranges up to 3450° F.

Norton ALUNDUM laboratory ware is supplied in general purpose crucibles, ignition capsules, incinerating dishes, melting crucibles, filter crucibles, cones, dishes, and discs, extraction thimbles, and combustion boats . . . in many sizes and shapes. Contact your laboratory supply house for complete data and prices.

WHATEVER YOUR REFRACTORY APPLICATION, Norton Research assures you the most practical application of special refractories to your individual requirements.


WHAT IS YOUR *Special* REFRACTORY PROBLEM?
Do you want refractories that last longer . . . that allow higher operating temperatures . . . that resist certain chemical reactions . . . that are more resistant to thermal shock and abrasion . . . that are better thermal conductors . . . that are better insulators . . . that have special electrical properties?
In other words, do you want refractories or porous mediums that are tailored to your exact requirements?
Then, Norton Research is the answer. A letter from you describing your product, process, and operating conditions will start Norton's Refractories Division to work on your problem.
Why be satisfied with catalyst supports, porous mediums or laboratory ware that are just *good enough*, when you may be able to improve your processes and reduce your operating costs with Norton products that are made to give the most satisfactory results under your conditions? Write today.
NORTON COMPANY
Refractories Division
599 New Bond Street, Worcester 6, Mass.
NORTON
Special REFRACTORIES
MAKING BETTER PRODUCTS TO MAKE OTHER PRODUCTS BETTER



DRY air blankets oil in storage

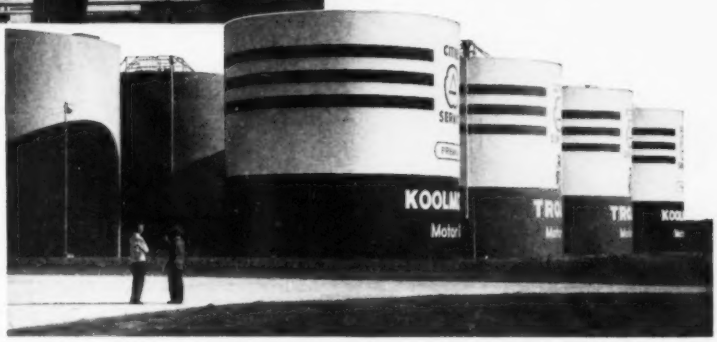
A Lectrodryer feeds DRY air into the manifold that distributes it to all the tanks. Automatic control maintains pressure on the manifold so that, as oil is drawn from the tanks, this air rushes in to take its place.

Thus Cities Service prevent contamination of their lubricating oils with moisture—a practice that's carried on at the refinery, aboard the ships transporting the oil, and here at Cicero, Illinois. Lectrodryers do that DRYing at all these points.

Whatever your moisture problem – in air, gases or organic liquids – there's probably a standard Lectrodryer able to solve it. Our engineers will advise you on DRYing methods and equipment, saving you time and money. Their experience covers every industry.

For this DRYing help, write Pittsburgh Lectrodryer Corporation, 332 32nd Street, Pittsburgh 30, Pennsylvania.

That manifold distributes DRY air to all the tanks in this Cities Service farm. The Lectrodryer that does this DRYing automatically is located in a small building right in the center of the tanks.



In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In Australia: Birlec, Limited, 51 Parramatta Road, Glebe, Sydney.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

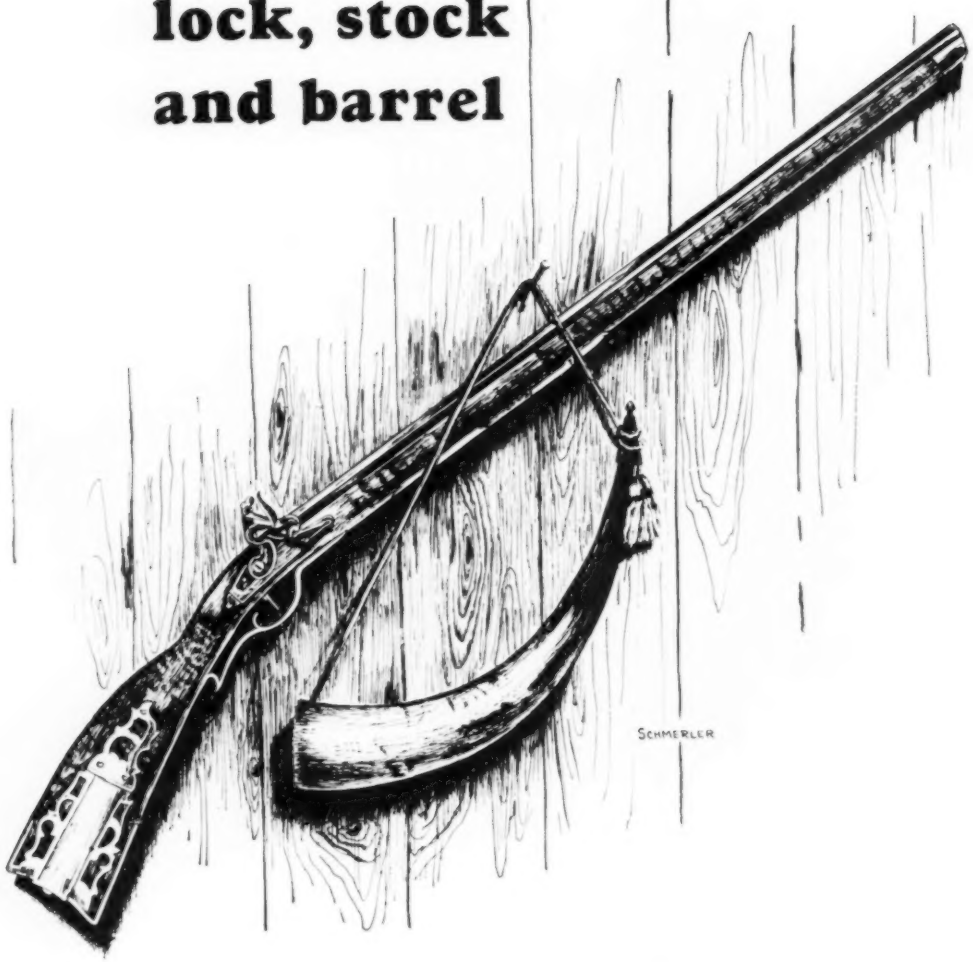
LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

REGISTERED TRADEMARK U.S. PAT. OFF

(To obtain more data on advertised products see page 1292)

lock, stock and barrel



(To obtain more data on advertised products see page 1292)

THAT'S ANOTHER WAY OF SAYING UOP SERVICE IS COMPLETE

As old as a museum piece, the meaning of the expression—lock, stock and barrel—is as significant today as it was in the days of the flintlock and powder horn. Handed down from generation to generation, it has become a familiar figure of speech.

In the same way, more and more refiners have come to associate UOP Service with the thought of completeness. And for good reason, too . . . because UOP Service goes all the way—from basic research and process design . . . through engineering, construction supervision, operator training and safety inspections . . . to assistance on normal and unusual problems of daily plant operation.

This complete Service is available to help every refiner operate his plant at highest efficiency and profitability.

UNIVERSAL OIL PRODUCTS COMPANY

UOP

General Offices: 310 S. MICHIGAN AVE. CHICAGO 4, ILLINOIS, U.S.A.
Laboratories: RIVERSIDE, ILLINOIS

Universal Service Protects Your Refinery

FAWLEY "ON STREAM" WITH . . .

Ohio Return Bends

The Largest Refinery in Great Britain

Fawley under construction by Foster Wheeler, Ltd.

Typical of Ohio's engineering and foundry "know-how" are the special 8" Ohio Type 1640 return bends, multiple-hole headers and flanged terminals. These were designed by Ohio to meet Foster Wheeler's specifications for special headers with large plugs for 8" O.D. tubes to use in the Fawley Refinery.

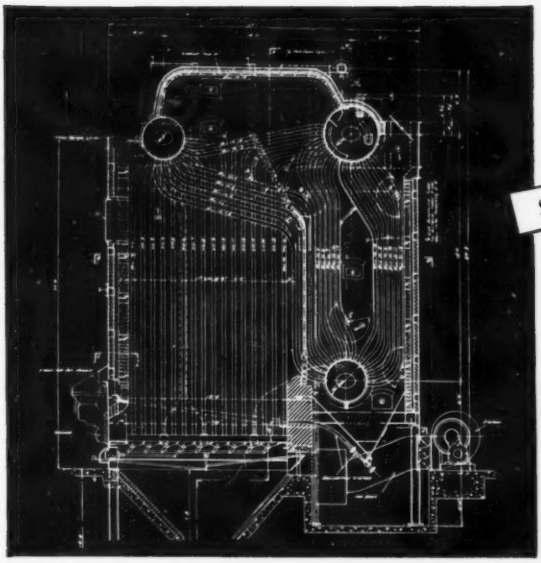
8"—6 hole Ohio Type 1640 Large-plug return bend

8"—3 hole Ohio Type 1640 Large-plug, Flanged Terminal Fitting

THE OHIO STEEL FOUNDRY CO.

LIMA, Ohio • • • PLANTS AT LIMA AND SPRINGFIELD, OHIO

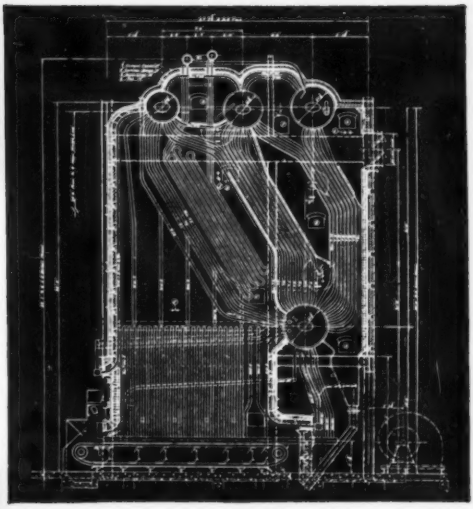
Quick Steaming at all Ratings!



Carry high overloads with high efficiency

SPECIFY **Vogt**

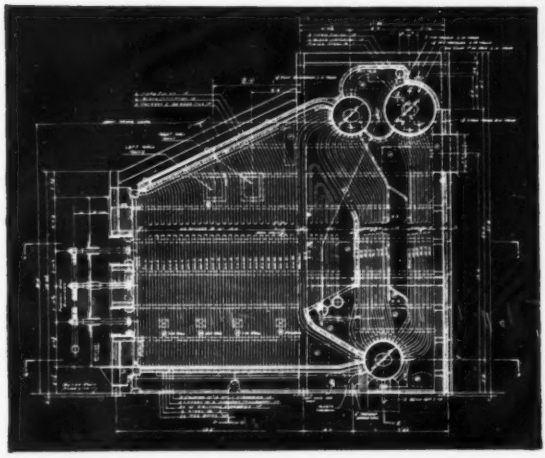
STEAM GENERATING UNITS



CLASS VL Two 27,500 pounds per hour units, installed at Brown-Forman Distillers Corporation, Louisville, Ky. Features large furnace volume in limited space, with high ratio of radiant heating surface.

CLASS LE Mr. Carmel Public Utility, Mr. Carmel, Illinois, is served by this 60,000 pounds per hour unit. Generous steam liberating surfaces and steam space permit wide fluctuations in load.

CLASS VR 70,000 pounds per hour steam generator at Humble Oil and Refining Company, Johnsue, Texas. An efficient, high-duty unit with water cooled furnace, using refinery gas fuel.



Vogt builds a complete line of bent tube steam generators, designed to burn solid, liquid, or gaseous fuels to meet specific operating conditions. Superheaters, air preheaters, economizers, water walls, and soot blowers can be readily incorporated. Bulletins with general information and showing typical installations are available upon request.

HENRY VOGT MACHINE CO.

LOUISVILLE 10, KENTUCKY

BRANCH OFFICES:
NEW YORK, PHILADELPHIA, CLEVELAND
CHICAGO, ST. LOUIS, DALLAS

(To obtain more data on advertised products see page 1292)

Here's Taylor's

2. Change from direct to reverse action is made easily, quickly by rotating top plate without disturbing any pipe connections.

1. Single knob adjustment of both proportional and reset control responses provides simple, quick stability "tune-in".

3. Plug-in manifold, with self-sealing valves, provides simple means for connecting or removing controller without disturbing pipe connections (optional).

5. Cover plate protects control knob from elements, damage, and tampering.

4. Integral cut-off relay on every Bi-Act, permits panel or field mounting.

New BI-ACT* CONTROLLER

Gives you single knob adjustment of both proportional and reset!

Here's a new, inexpensive force-balance controller incorporating a new control circuit. *One* stability knob adjusts *both* proportional and automatic reset responses. It's adaptable to practically any process . . . flow, pressure, liquid level and temperature . . . and particularly suited to applications requiring fast reset rates and broad proportional bands.

The BI-ACT CONTROLLER can be panel or field mounted. It can be changed from direct to reverse action and, with optional manifold, removed entirely without disturbing piping connections. SPECIFICATIONS: Gain 100 to .5 (Throttling range 1% to 200%) Automatic reset .1 to 120 repeats per minute. Size 7½" overall length. Standard operating range 3 to 15 psi. High capacity air valve.

This new BI-ACT CONTROLLER is the latest addition to Taylor's famous TRANSET* CONTROL SYSTEM, the new concept in pneumatic transmission control that is the talk of industry. Three component units, TRANSAIRE* TRANSMITTERS, TRI-ACT* or BI-ACT* CONTROLLERS and TRANSET* RECORDERS or INDICATORS, work together as a team to take full advantage of each others' superior performance in controlling practically any process variable.

For full details ask your Taylor Field Engineer, or write for Bulletin 98070. Taylor Instrument Companies, Rochester 1, N. Y., and Toronto, Canada.

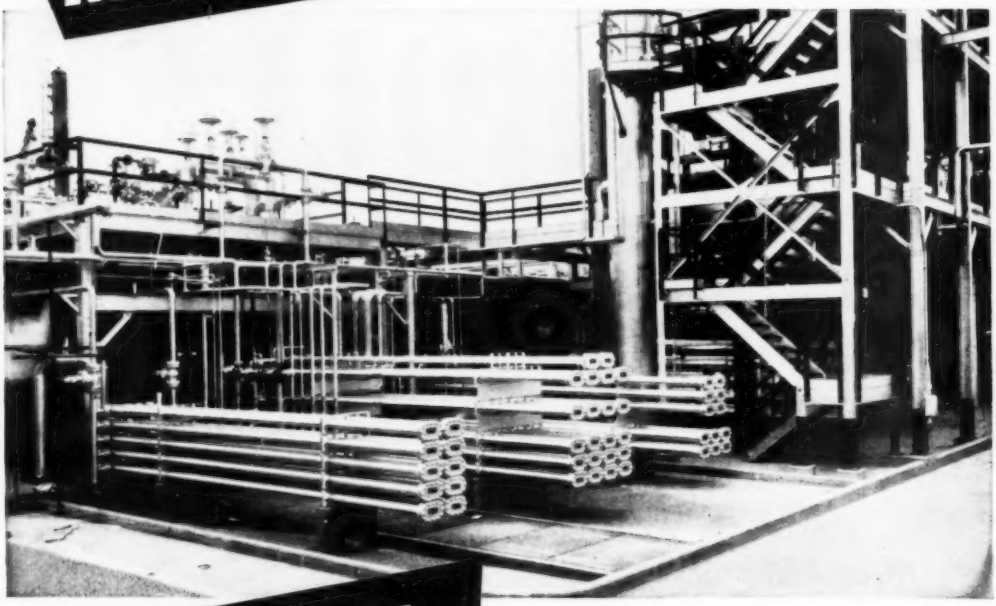
Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.

Taylor's Centennial ACCURACY FIRST SINCE 1851

*Trade Mark

Taylor Instruments MEAN ACCURACY FIRST IN HOME AND INDUSTRY

Easier Maintenance in your plant



with **BROWN FINTUBE** *sectional hairpin heat exchangers*

● Brown Fintube Sectional Heat Exchangers make maintenance easier and less costly. The integral welded-on fins *positively can not* work loose from the center tube. Their efficient heat transfer at low "skin" temperatures, and the absence of baffles and stagnant areas in the exchanger, minimize coking and fouling.

The ingenuous head end assembly, employing a ring joint seal, and the easy to handle rear end cover plate permit an exchanger to be opened, a clean hairpin substituted, and the exchanger put back on stream again in less than ten minutes. For top operating efficiency and easier, less costly maintenance, write for Brown Fintube ***Bulletin No. 481.***

THE BROWN FINTUBE CO.

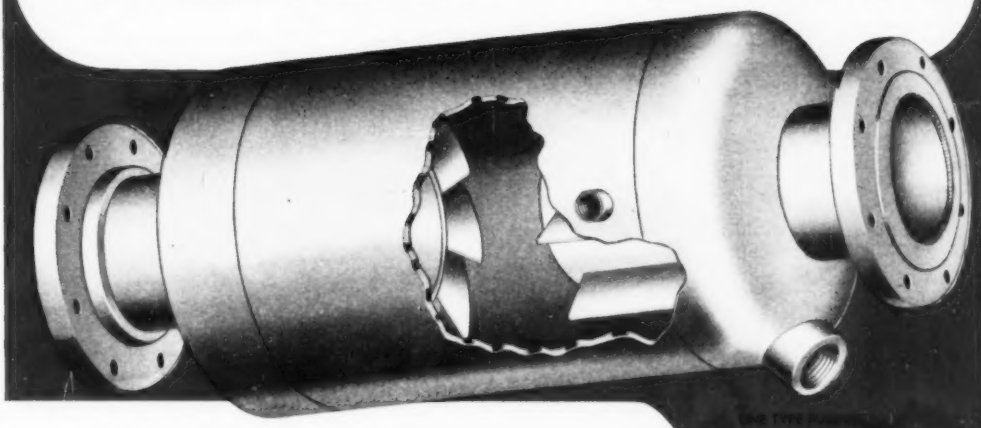
Elyria, Ohio

Sectional Hairpin Heat Exchangers
Tank Suction and Line Heaters
Fintube Heaters for Bulk Storage Tanks
Indirect Process Air Heaters
Fintube Heaters for Processing Tanks
Integrally Welded Fintubes for Any Heating, Cooling or Heat Transfer Service

NEW YORK • BOSTON • PHILADELPHIA • WILMINGTON • PITTSBURGH • BUFFALO • CLEVELAND • CINCINNATI • DETROIT • CHICAGO
ST. PAUL • ST. LOUIS • MEMPHIS • BIRMINGHAM • NEW ORLEANS • TULSA • HOUSTON • LOS ANGELES • SAN FRANCISCO

Save Money with - - - -

Anderson Hi-eF Line Type Purifiers



LOW COST UNITS REMOVE 100% ENTRAINMENT

You can *substantially* reduce your cost for separating equipment by specifying Anderson Hi-eF Line Type Purifiers. Now, for the first time, you can purchase high efficiency purifiers for the price of an ordinary separator! This fact is made possible by new, efficient production methods plus a new improved purifier design perfected by Anderson engineers with over 27 years experience in the development and special application of high efficiency purifiers. Despite the economy of first cost, Line Type Hi-eF Purifiers are unsurpassed by any similar unit—remove virtually 100% entrainment from gases and vapors.

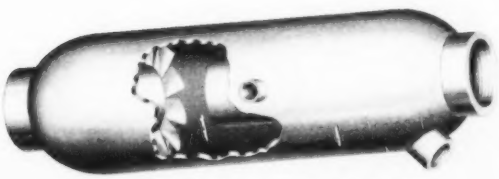
Anderson Line Type Hi-eF Purifiers pay rich dividends by removing entrained liquids, solids, condensates, oil or grease from live or exhaust steam, from processed gas, air, or chemical vapors.

Self cleaning, they have no moving parts or baffles . . . need no attention or periodic servicing. Good design permits extremely low pressure drop.

Save money. Specify low-cost Anderson Hi-eF Purifiers. Anderson manufactures all types in all sizes to any specifications. Mail coupon today for prices and bulletins.

ANDERSON Hi-eF PURIFIERS

MADE BY THE MAKERS OF SUPER-SILENCTOR STEAM TRAPS AND STRAINERS



LINE TYPE PURIFIER, screwed connections, Bulletin #500

PURIFIER DIVISION,
THE V. D. ANDERSON COMPANY
1974 West 96th Street • Cleveland 2, Ohio

Gentlemen: Please send additional information on Anderson Hi-eF Purifiers described in:

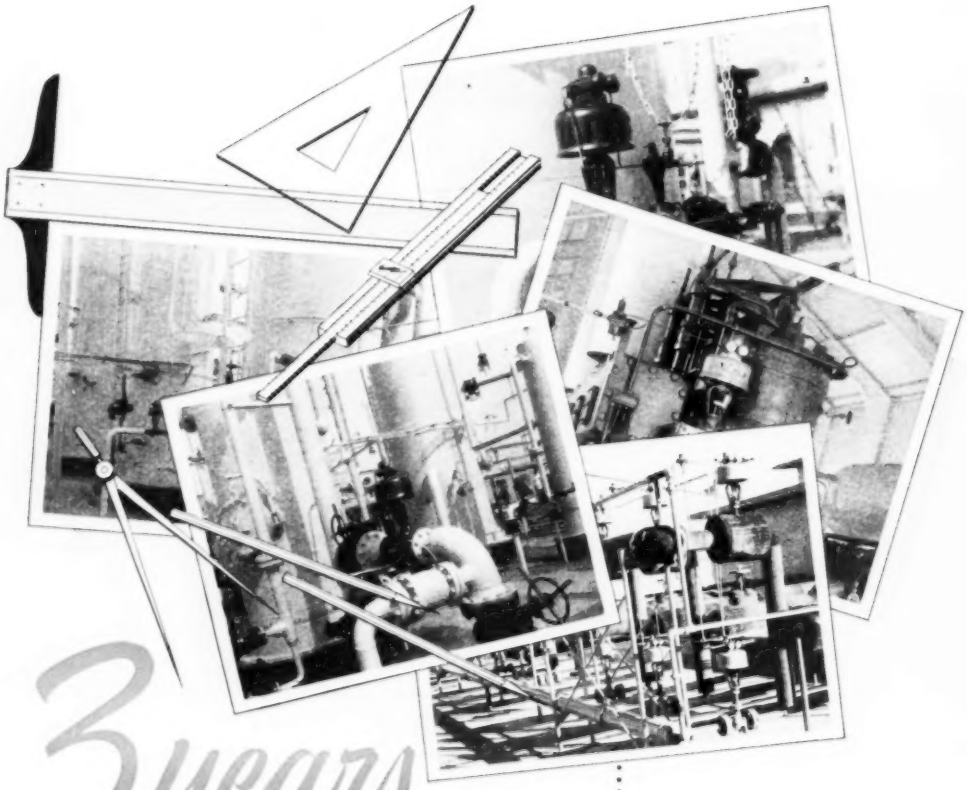
☐ Bulletin #200 ☐ Bulletin #500

Name .....

Company .....

Address .....

City ..... Zone State .....



3 years...

IN

MODERN DESIGN AND USER ACCEPTANCE PUT 7500 ANNIN VALVES IN SERVICE

The thousands of ANNIN Valves in service today are a testimonial not only to their many design advantages but also to the phenomenal acceptance they have won in the field. Valve buyers and instrumentation engineers after putting their first ANNIN Valves to work "spread the word" that here were valves assuring positive control as well as versatility and ease of maintenance. Since 1948 when the first ANNIN Valve was made, many new features and models are being continually added to provide superior valves for the processing industry. Write today for new complete catalog of ANNIN Valves.

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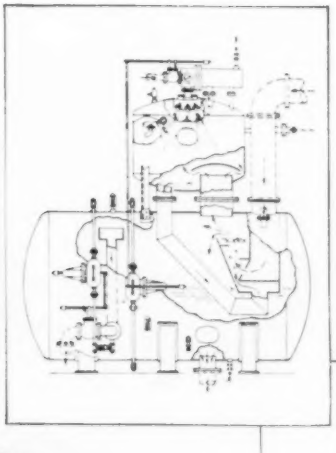
ELECTRO-PNEUMATIC

HANDWHEEL

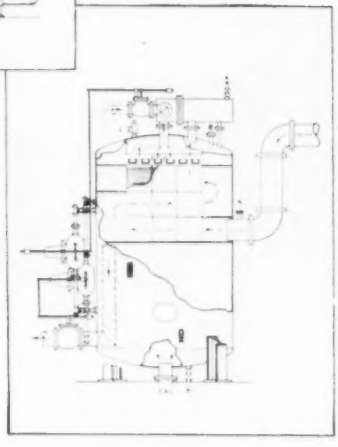
COMBINATION

ANNIN VALVES

THE ANNIN COMPANY 3500 Union Pacific Avenue, Los Angeles 23, California



Spray



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GRAVER

has the right

Deaerating Heater

for YOUR power plant needs

GRAVER manufactures EVERY type of deaerating heater . . . spray and tray designs . . . vertical and horizontal . . . with or without storage tank . . . for installation within or outside a building . . . and special designs for limited space or head room.

Each GRAVER Heater is DOUBLY guaranteed . . . to deliver water preheated to full steam temperature, and to reduce oxygen to less than 0.005 ml liter as measured by the most precise analytical methods • **Write today for complete information.**

GRAVER

Equipment for Every Water Conditioning Process

GRAVER WATER CONDITIONING CO.

Division of Graver Tank & Mfg. Co., Inc.

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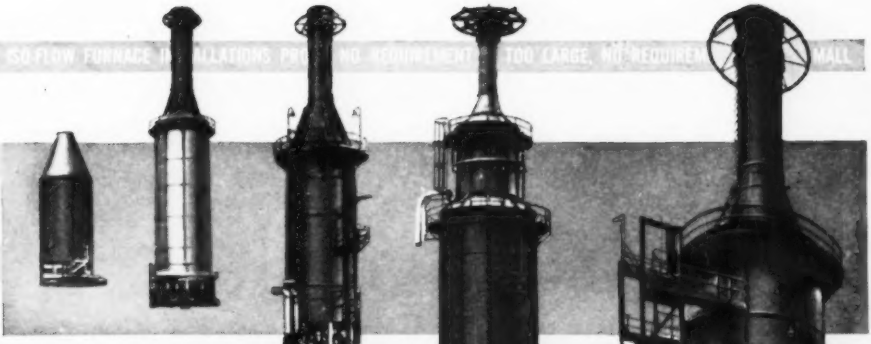
GW428

935 PETRO-CHEM ISO-FLOW FURNACE INSTALLATIONS PROVE NO REQUIREMENT IS TOO LARGE, NO REQUIREMENT IS TOO SMALL

There's a

ISO-FLOW FURNACE for every process requirement for the petroleum and chemical industries.

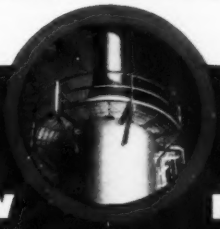
We're now building two Iso-Flow heaters of 159 million BTU capacity each.



DUTY
TEMPERATURE
PRESSURE
EFFICIENCY

-----for any

. . . and all Petro-Chem Iso-Flow Furnaces are pre-eminently satisfactory.



PETR CHEM
ISO-FLOW FURNACES

PETRO-CHEM DEVELOPMENT CO., INCORPORATED
120 EAST 41ST STREET, NEW YORK 17, N. Y.

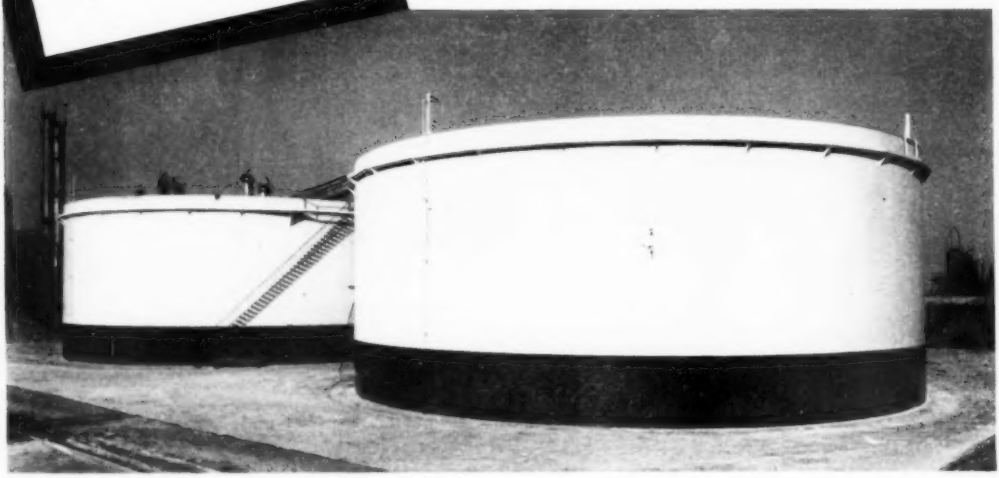
Representatives: Bethlehem Supply, Tulsa and Houston · Flagg, Brackett & Durgin, Boston · D. D. Foster, Pittsburgh · Faville-Levally, Chicago · Lester Oberholz, California · Gordon D. Hardin, Louisville, Kentucky

 (To obtain more data on advertised products see page 1292)

CHECK LIST

- ✔ Standing Storage
- ✔ Blending Stock Storage
- ✔ Working Storage

HORTON Double-Deck Floating Roofs . . . prove their efficiency for many types of storage



The two 35,000-bbl. tanks with Horton Double-Deck Floating Roofs (shown above) are used for three different types of storage at the Los Angeles refinery of the Union Oil Company. They hold gasoline in *standing* storage and in *working* storage depending on daily refinery requirements, and they are also used for *blending stock* storage.

Such versatility has always been one of the biggest advantages of Horton Double-Deck Floating Roofs and has made them standard equipment throughout the petroleum industry. In each of these three distinct uses, they have proved superior by eliminating filling and breathing losses, reducing the danger of fire in the storage area, and cutting down on corrosion on the underside of the roof.

Horton Double-Deck Floating Roofs ride directly on the liquid in the tanks, and thereby eliminate the space where vapor might collect. They are also equipped with the improved Horton Seal which prevents evaporation from taking place in the space between the deck of the floating roof and the tank shell.

For more information about Horton Double-Deck Roofs, Pontoon Roofs, or Pan Floating Roofs, write our nearest office. There is no obligation on your part.

CHICAGO BRIDGE & IRON COMPANY

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA

Atlanta 3	2103 Healey Building	Detroit 26	1532 Lafayette Building	Salt Lake City 4	530 West 17th South Street
Birmingham 1	1527 North Fiftieth Street	Houston 2	2130 National Standard Building	San Francisco 4	1559-200 Bush Street
Boston 10	1029-201 Devonshire Street	Los Angeles 17	1526 General Petroleum Building	Seattle 1	1330 Henry Building
Chicago 4	2114 McCormick Building	New York 6	3310-165 Broadway Building	Tulsa 3	1620 Hunt Building
Cleveland 15	2215 Guildhall Building	Philadelphia 3	1630-1700 Walnut St. Building	Washington 6, D. C.	1135 Cafritz Building

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Ateliers et Chantiers de la Seine Maritime, Paris, France
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Compagnia Tecnica Industrie Petroli, Rome, Italy
Whessoe Limited, Darlington, England
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Comprimo N. V., Amsterdam-O, Netherlands
Sociedade Chibridge de Construcoes Ltda., Av. Franklin Roosevelt, 194-S 704 C, Rio de Janeiro, Brazil

Growing Faster Than All Get-Out!

It takes a lot of shoes, socks, shirts and chow to keep up with a growing boy. And it requires a lot of process equipment, materials and services to keep up with expansion in the world's fastest changing market . . . the petroleum processing industry.

In a public statement, Bruce K. Brown, Deputy Administrator, Petroleum Administration for Defense, said that . . . "by December, 1953, basic refining capacity should be increased at least *one million* barrels (or 11.5%) per day over the daily capacity recorded in December, 1950. This is a minimum program figure, representing the largest expansion program in the refining industry's history, and does not reflect potential war needs."

Naturally, with expansion like this, refining men are called upon to keep up to the minute on technological developments, and materials and equipment changes. To assist them in this, they have learned to depend upon *Petroleum Processing*. That's where they'll read your advertising message, too.

★ **DOES YOUR PRODUCT FIT THIS MARKET?** A refinery warehouse contains up to 75,000 different kinds of equipment. Write today for your free copy of "Selling the World's Fastest Changing Market," a 52-page booklet prepared as a guide to the advertising people and salesmen who need to know the peculiarities of selling the refining equipment market.

THE BEST-READ REFINERY PUBLICATION
REACHING THE MOST REFINERY READERS

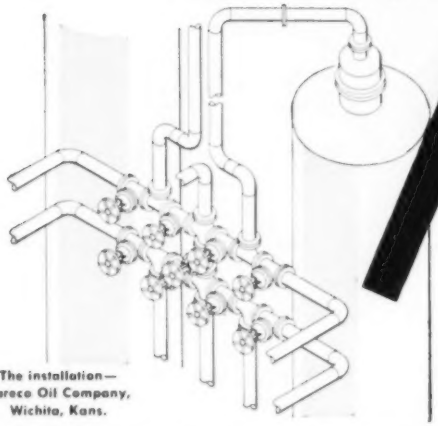
A Platt Petroleum Publication

Headquarters, 1213 W. Third St., Cleveland 13, Ohio . . . Offices in New York, Chicago, Philadelphia, Houston and Los Angeles

for outstanding service

on Gasoline Desulfurization

...for example



The installation—
Barsco Oil Company,
Wichita, Kans.

PROBLEM: To select valves that would stay absolutely tight on hot gasoline, steam-air mixture, and catalyst regeneration waste gases, for control manifold to reaction chambers on Perco Cycloversion unit.

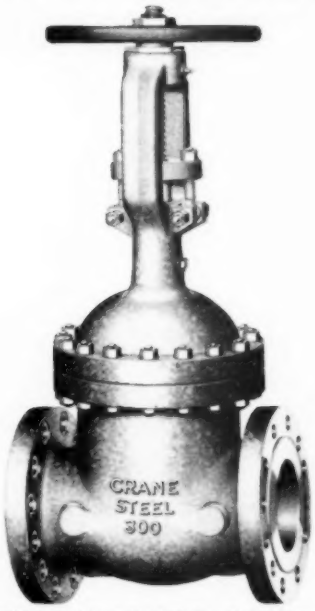
WORKING CONDITIONS: Cyclic operation; approximately 15-day cycles. At oil inlet, straightrun gasoline handled at 950 Deg. F., 85 psi. For catalyst regeneration, air-steam mixture at 850 Deg. F., 15 psi. Regeneration waste gases, 1200 Deg. F., 5 psi.

SOLUTION TO PROBLEM: Crane 8-inch, 300-Pound, No. 5 Chrome-Molybdenum Alloy Steel Wedge Gate Valves, with Stellite seats and patented flexible disc design.

RESULTS: After more than 2 years' service, all Crane valves are absolutely tight and operating at highest efficiency, with no maintenance.

ANOTHER TYPICAL CASE HISTORY, demonstrating the low ultimate cost of Crane Valves of every type. And the reason why . . .
More Crane Valves are used than any other make!

. . . Equip with Dependable Quality CRANE VALVES

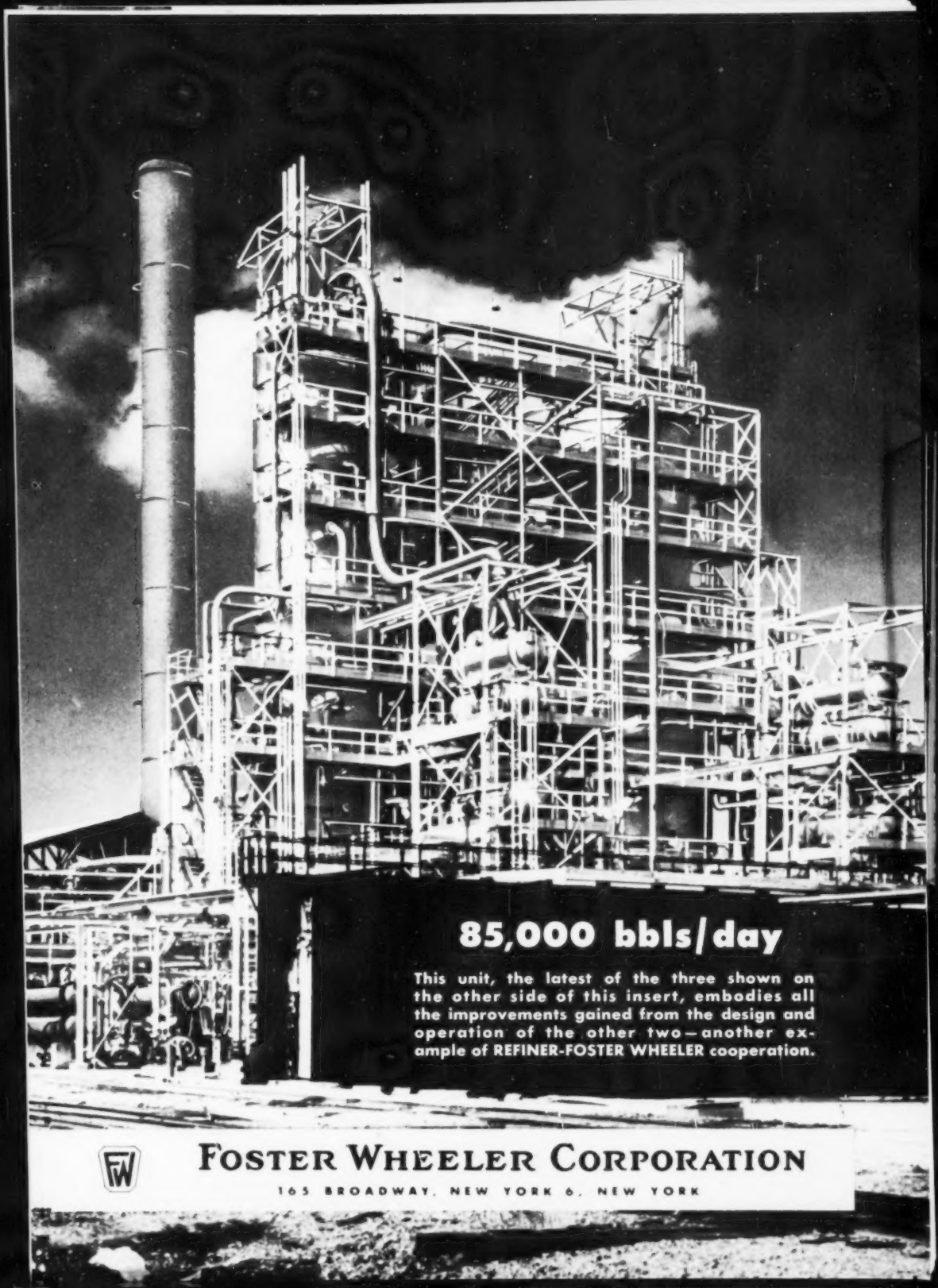


300-Pound Cast Steel Wedge Gate Valve. In body and trim materials for all refinery services. See your Crane Catalog.

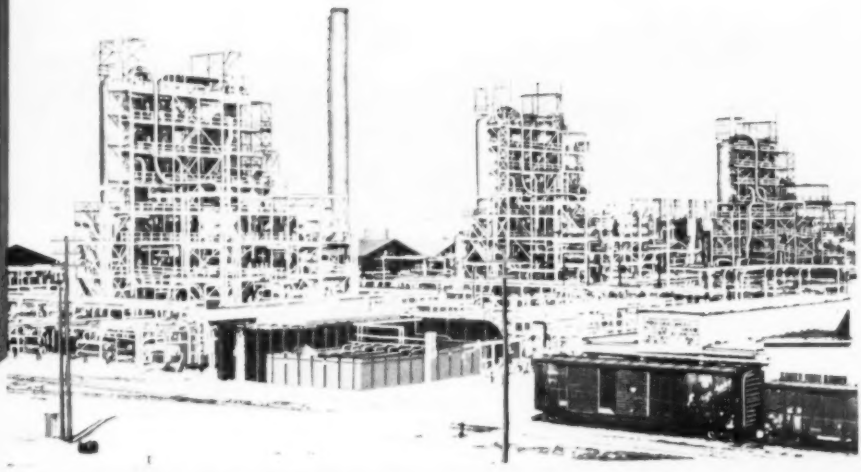
CRANE CO.

General Offices:
836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING


85,000 bbls/day
This unit, the latest of the three shown on the other side of this insert, embodies all the improvements gained from the design and operation of the other two—another example of REFINER-FOSTER WHEELER cooperation.
FOSTER WHEELER CORPORATION
165 BROADWAY, NEW YORK 6, NEW YORK

225,000 bbls/day



These three crude distillation units, in operation in a Gulf Coast refinery with a combined capacity of 225,000 barrels per day were . . . . . .

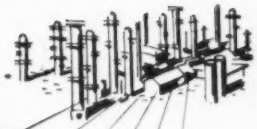
designed
and
constructed
by

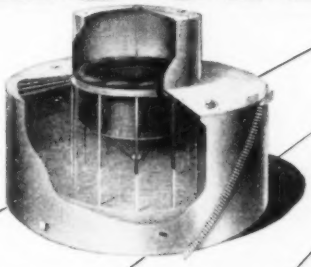
FOSTER WHEELER

165 BROADWAY, NEW YORK 6, NEW YORK

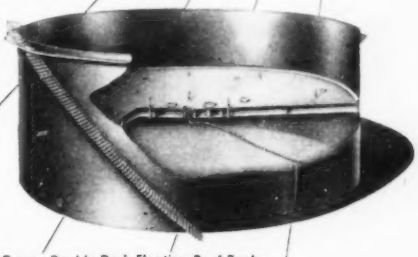
GRAVER

EXCLUSIVES

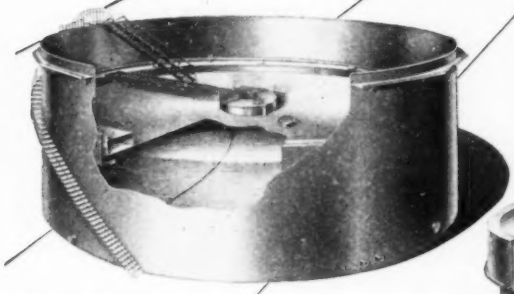




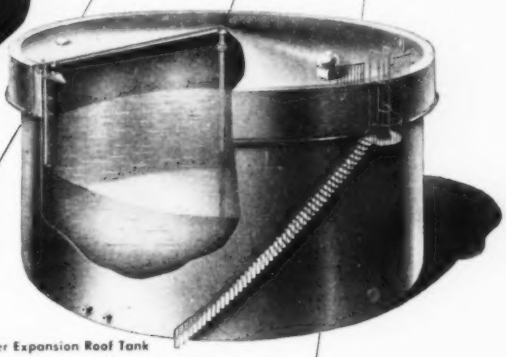
● Graver Vapor-Mizer



● Graver Double Deck Floating Roof Tank



● Graver Center-Weighted Floating Roof Tank



● Graver Expansion Roof Tank

These four Graver fabrications — each a patented design — are built not only to *conserve* but also to *preserve* the quality of the petroleum product. For this reason, the Graver principle of Conservation Control saves the volatile elements of gasoline, thus effecting economy and insuring motorists the same *high quality* that has been built into the motor fuel at the refinery!

GRAVER TANK & MFG. CO., INC.

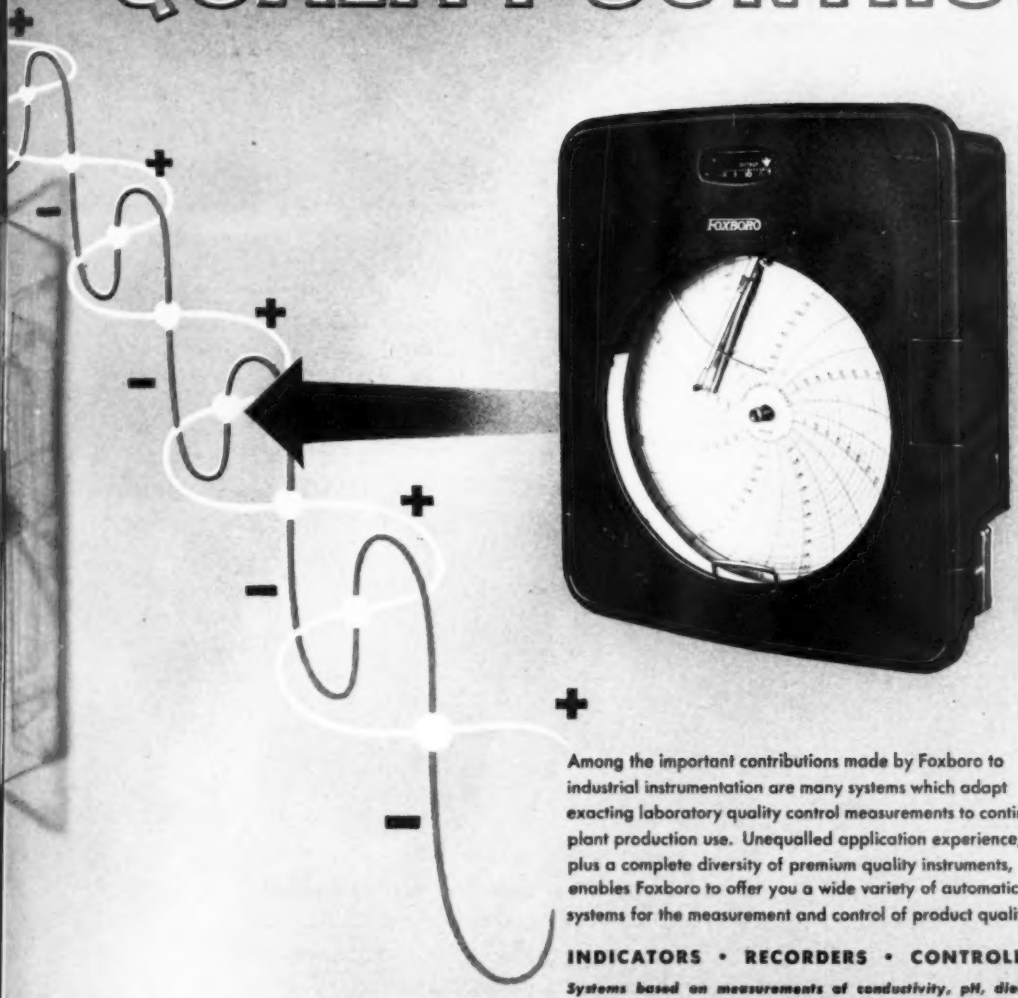
EAST CHICAGO, INDIANA

NEW YORK · CHICAGO · PHILADELPHIA · WASHINGTON
DETROIT · CINCINNATI · CATASAUQUA, PA.
HOUSTON · SAND SPRINGS, OKLA.

(To obtain more data on advertised products see page 1292)

better instrumentation for

QUALITY CONTROL



Among the important contributions made by Foxboro to industrial instrumentation are many systems which adapt exacting laboratory quality control measurements to continuous plant production use. Unequalled application experience, plus a complete diversity of premium quality instruments, enables Foxboro to offer you a wide variety of automatic systems for the measurement and control of product quality.

INDICATORS • RECORDERS • CONTROLLERS

Systems based on measurements of conductivity, pH, dielectric constant, oxidation-reduction potential, boiling point rise, differential vapor pressure, specific gravity . .

TRANSMISSION SYSTEMS • CONTROLLED VALVES

FOXBORO

Reg. U. S. Pat. Off.

For over 40 years, specialists in the measurement and control of temperature, pressure, flow, liquid level, humidity . . .

THE FOXBORO COMPANY, FOXBORO, MASSACHUSETTS, U.S.A.

If SOUR CRUDE is your problem

The Tannin Solutizer Process* may be your answer

As more and more sour crude must be refined, the advantages of this mercaptan-removal process become increasingly attractive.

This is the process that replaces doctor treating and reduces TEL requirements . . . without affecting either the quality or the stability of the treated gasoline.

Converting to the Tannin Solutizer Process requires a minimum investment in new equipment . . . very likely your present equipment will serve with little change.

Operating economy is an outstanding advantage of the Tannin Solutizer Process . . . *this process is not corrosive*, does *not* require equipment of special alloys.

Complete engineering service is available . . . to help plan your unit, to supervise start-up, to assist in later operation if required. We welcome the opportunity to work with you in extending the benefits of the Tannin Solutizer Process.

*The Tannin Solutizer Process is licensed under the patent rights of Socony Vacuum Oil Company and Shell Development Company.

SHELL DEVELOPMENT COMPANY
50 WEST 50TH STREET • NEW YORK 20, N.Y.

SHELL

CITIES SERVICE CAT CRACKER
AT EAST CHICAGO, INDIANA

...ON THE LINE

785

CONSECUTIVE DAYS

... with the B-L lining still in perfect shape!

This is an unretouched photograph of the Bigelow-Liptak regenerator lining at the end of the record run.

Here's a world's record for a cat cracker's initial run which will be hard to beat. Interesting to us—and to you, if you are contemplating a new installation—is the fact that the Bigelow-Liptak regenerator lining is still in perfect shape after its two-year-plus beating. During this shut down, no repairs to refractory tile were made.

Add to this a previous world's record: the Tidewater cracker at Avon, California, which was on stream 610 days. This, too, had a B-L lining.

You, too, can enjoy the durability and economy of a Bigelow-Liptak *engineered* enclosure for your next industrial furnace. Write today.

BIGELOW LIPTAK Corporation

BIGELOW-LIPTAK

Unit-Suspended Walls & Arches

CURTIS BUILDING • DETROIT 2, MICHIGAN

IN CANADA

BIGELOW-LIPTAK OF CANADA, LTD., TORONTO, ONTARIO

ATLANTA • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DENVER • HOUSTON • KANSAS CITY, MO. • LOS ANGELES • MINNEAPOLIS • NEW YORK
PITTSBURGH • PORTLAND, ORE. • ST. LOUIS • ST. PAUL • SALT LAKE CITY • SAN FRANCISCO • SAULT STE. MARIE, MICH. • SEATTLE • TULSA • VANCOUVER, B.C

Can YOU Use the "Utiliscope"?

The advertisement at the right appeared in BUSINESS WEEK. It has been suggested that this ad contains considerable food for thought for the readers of PETROLEUM PROCESSING also. The steel making application illustrated here may not interest you but it probably will suggest other uses for the "Utiliscope" in your operations.

If you want to look into the possibilities of the "Utiliscope", simply write us for a copy of Bulletin 1025B which explains the equipment and shows various applications. Please address your request to Department "B".

Diamond Power Specialty Corp.
Department "B"
Lancaster, Ohio

NOW You Can *See* Where You Can't *Look*

Eliminating Hazards and Reducing Costs

IN STEEL MAKING with the

DIAMOND "UTILISCOPE"

(WIRED TELEVISION)

Continuous casting of billets is a process which promises very important reduction of steel making costs. Formerly, a man had to stand close to the stream of molten steel watching the surface of the metal in the mold and always ready to signal the operator 50 feet away. The hazard was great and discomfort from radiant heat quickly became unbearable.

Now, a "Utiliscope" (wired television) camera with a long focal length lens is placed above the metal surface. The viewer is placed at the control panel. The operator can see everything that happens at close range in comfort and safety . . . can watch more effectively than a man close to the molten steel.

This is one of the many applications where the Diamond "Utiliscope" promotes safety . . . improves operation . . . saves labor. The "Utiliscope" extends the power of the eye so you can see around corners, through walls, into fire and through water. It is simple and easy to use. Installation requires no special skill. Adjustment of focus, brilliance and contrast is quickly and easily made.

You may have a place where the "Utiliscope" will save you money, or solve a difficult problem. Write for Bulletin 1025 with complete description; it suggests many possible uses.

OTHER USES

- Studying destructive tests of engines
- Checking remote gage readings
- Observing conditions inside furnaces
- Viewing nuclear research
- Coordinating material flow on conveyors

The "Utiliscope" (Reg. U. S. Patent Office)

WRITE FOR BULLETIN 1025B

DIAMOND POWER SPECIALTY CORP.
First in Industrial Television
LANCASTER, OHIO
DIAMOND SPECIALTY LIMITED
Windsor, Ontario

Since 1903, Diamond has Manufactured Quality Equipment for Industry

...from billet to tube to fitting

From this modern control room, every step in the heating, piercing, rolling and reduction of seamless tubes is closely monitored. This is typical of the highly specialized equipment demanded by the Globe precision process . . . insuring high quality and close tolerances.

GLOBE highly specialized process controls are used to produce the finest in WELDING FITTINGS

For complete information on the finest welding fittings available anywhere, send for the Globe Welding Fittings Catalog.

Globe precision-process manufacture *begins with the billet* — continues through the making of the seamless steel tube — (Globe alone among welding fitting manufacturers produces seamless steel tubes) — and extends through to the production of the finished fittings.

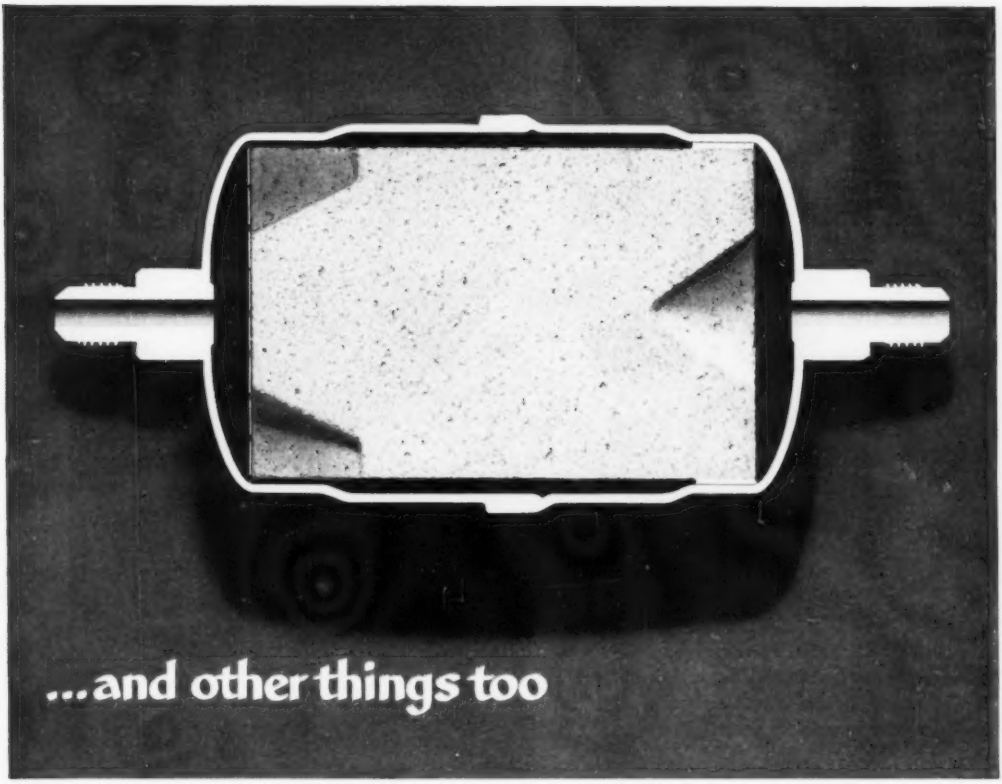
Because Globe has highly specialized controls — at every stage of manufacture *in its own plant* — you can be sure of uniform high quality seamless welding fittings when you specify Globe.

GLOBE STEEL TUBES CO.
MILWAUKEE 46, WISCONSIN

Chicago, Cleveland, Detroit, New York, Philadelphia, St. Louis, Denver, Houston, San Francisco, Glendale, Cal.

Producers of Globe seamless stainless steel tubes — Gloweld welded stainless steel tubes — alloy — carbon — seamless steel tubes — Globeiron (high purity ingot iron) seamless tubes — Globe Welding Fittings.

The inside story on drying refrigerants



Continually maintaining a *dry* refrigerant is essential to the operation of any refrigeration system. But *how much* moisture is removed is far less important than *how little* is left—even a drop of water can cause expensive breakdowns. An exceptionally efficient drying agent—such as ALCOA *Activated* Alumina—is required for such an exacting job.

That's why Sporlan Valve Company, St. Louis, Mo., put ALCOA *Activated* Alumina inside their Catch-All Filter-Drier, illustrated above. Molded of granulated alumina, the unique porous core dries refrigerants to an end point so low that any remaining moisture is harmless. Moreover, it cannot channel or powder because ALCOA *Activated* Alumina is a thoroughly reliable, non-corrosive drying agent that will not change its form or properties—will not swell, soften or disintegrate.

Helping to keep refrigerators cold is only one of many jobs ALCOA *Activated* Alumina is doing successfully. Its desiccating properties are finding widespread application in the chemical, food, pharmaceutical and petroleum industries, in air conditioning, and for the maintenance of transformer and lubricating oils.

You should be taking advantage of the economies offered by ALCOA *Activated* Alumina. We'll gladly send you additional information. Write to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 6161 Gulf Building, Pittsburgh 19, Pa.

Alcoa Chemicals

ALCOA ALUMINAS and FLUORIDES

ACTIVATED ALUMINAS • CALCINED ALUMINAS • HYDRATED ALUMINAS • TABULAR ALUMINAS • LOW SODA ALUMINAS ALUMINUM FLUORIDE • SODIUM FLUORIDE • SODIUM ACID FLUORIDE • FLUOBORIC ACID • CRYOLITE • GALLIUM

PENETRATES---

cracks...joints...rivet holes

TO PROTECT METAL 4 WAYS

Rust and corrosion find weak spots in a priming film *fast*, in petroleum service.

That's why KROMIK® has proved such an outstanding, standard priming material, not only in the petroleum industry, but in railway, marine and structural steel service, for year after year after year.

KROMIK outperforms single-pigment primers because, for one reason, it is formulated to *penetrate* into joints and rivet holes . . . to cover evenly, whether brushed or sprayed, avoiding the weak spots that occur with heavy-pigmentation primers that leave "valleys" when brushed. KROMIK dries through, forming a tough, tight film that withstands weather and abrasion . . . lends itself well to application of aluminum paint and either dark or light-colored finishing coats.

Ask for proof. Check your Sherwin-Williams representative or write The Sherwin-Williams Co., 101 Prospect Avenue, Cleveland 1, Ohio.

KROMIK

the 4-pigment primer

1. **PREVENTS RUST**
   KROMIK incorporates the best protective properties of *red lead* to resist moisture —stop rust before it starts.
2. **INHIBITS CORROSION**
   Zinc chromate—another protective pigment —adds extra resistance against corrosion.
3. **RESISTS ABRASION**
   Zinc oxide aids drying and hardness— makes KROMIK equal to most top coats in toughness and resistance to abrasion.
4. **WITHSTANDS WEATHER**
   Iron oxide enables KROMIK to withstand sun and weather even if exposed for long periods before top coats are applied.

SHERWIN-WILLIAMS

PETROLEUM FINISHES

THE *Peerless*

HYDRO-LINE

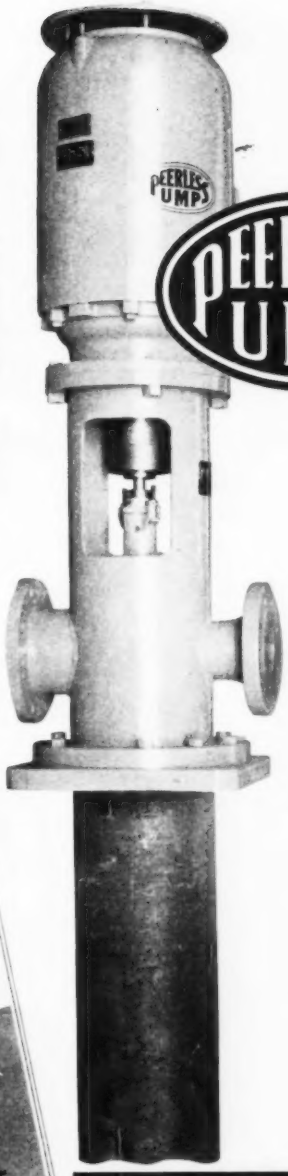
ENCASED CLOSE-COUPLED VERTICAL CENTRIFUGAL PUMP

FOR LIMITED NPSH APPLICATIONS IN ALL INDUSTRIAL PROCESSES

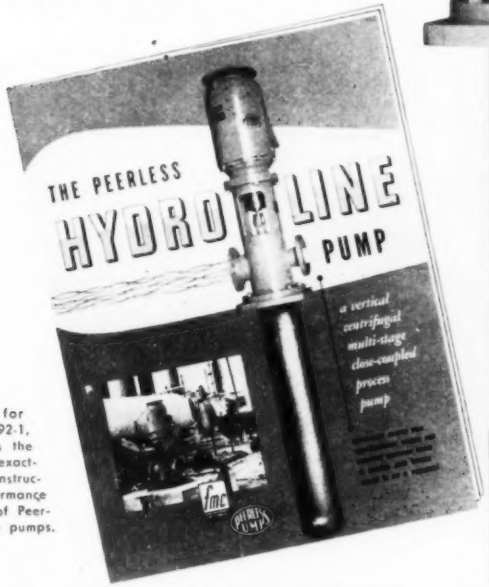
...and for installation where floor space is at a premium

For application to: Petroleum Refining Techniques · Line Booster Service · Chemical Processing · Condensate Return Service.

Especially Suited for Pumping: Hydrocarbons, such as Gasoline, Butane, Propane, Oils, etc. · Hot or Cold Water · Acids · Bases · Salt Solutions, in mild or concentrated form at temperatures from normal to 400 F.



PEERLESS PUMPS



USE COUPON for Bulletin No. B-592-1, which describes the successful and exacting design, construction and performance characteristics of Peerless Hydro-Line pumps.

HYDRO-LINE CHARACTERISTICS AT A GLANCE

CAPACITIES
Up to 5000 gpm

HEADS
Up to 1500 feet

DRIVES
As required; standard vertical, solidshaft, hollowshaft or explosion-proof motors; steam turbine.

SEALING CHAMBER
Peerless mechanical shaft seal standard construction or packing gland furnished as required.

MATERIALS
Cast iron bowls, bronze impellers, #416 stainless steel shaft standard; any special materials can be furnished on order to suit individual requirements.

MAIL COUPON FOR BULLETIN

PEERLESS PUMP DIVISION
Food Machinery and Chemical Corporation
301 West Avenue 26
Los Angeles 31, California

Please send us copy of Peerless Hydro-Line Pump Bulletin No. B-592-1.

NAME _____

COMPANY _____

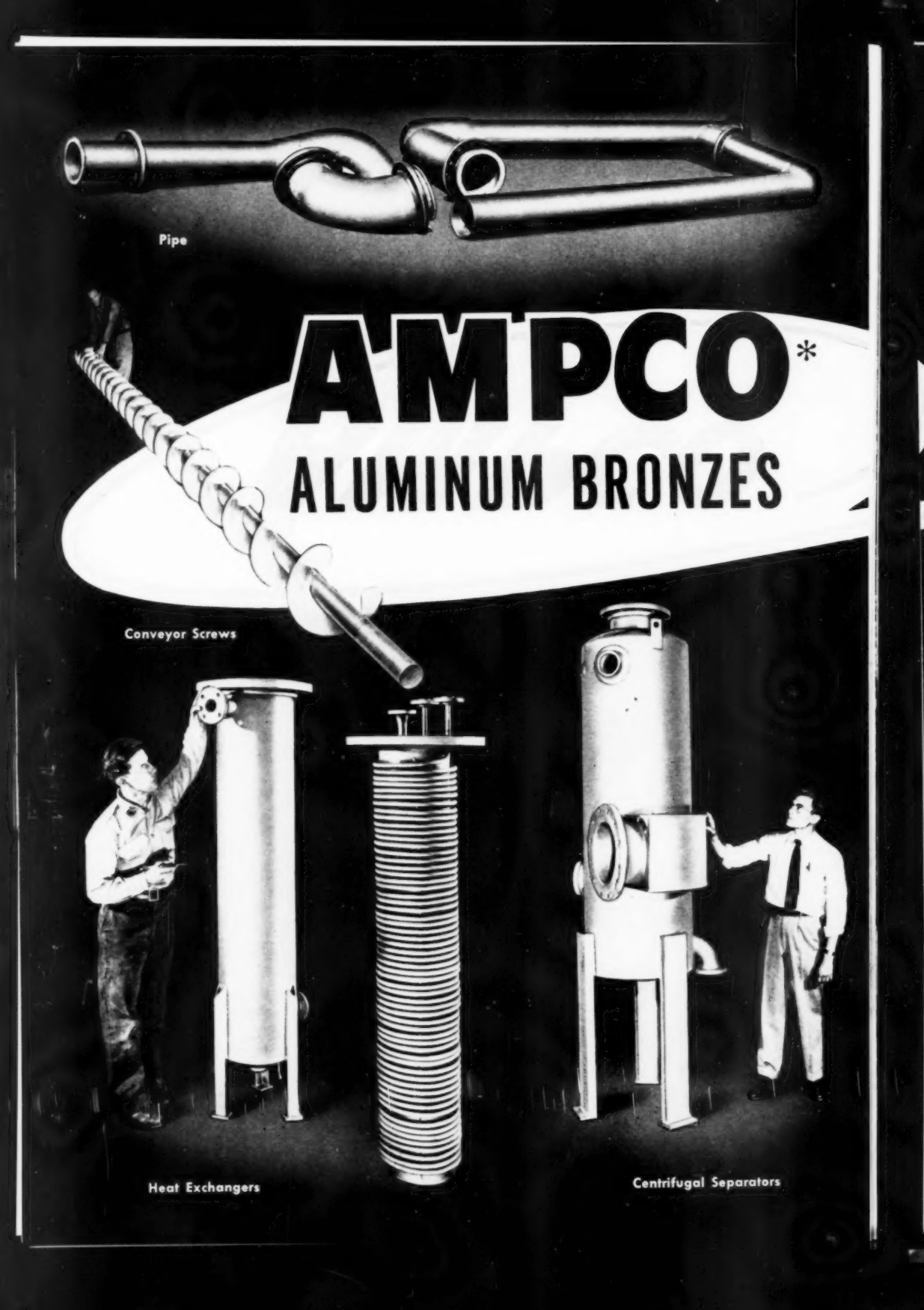
STREET _____

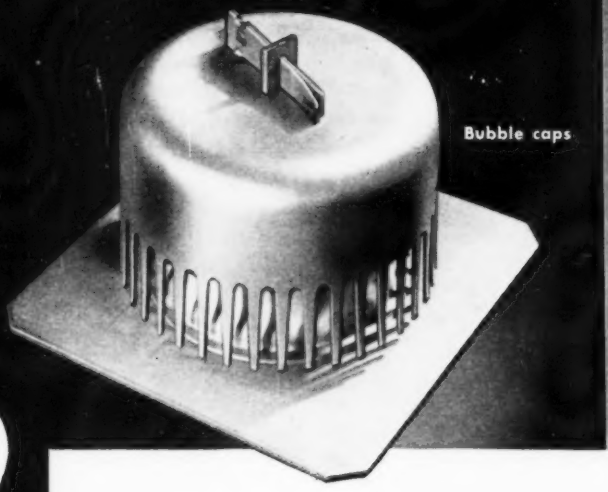
CITY _____ STATE _____

PET PROC

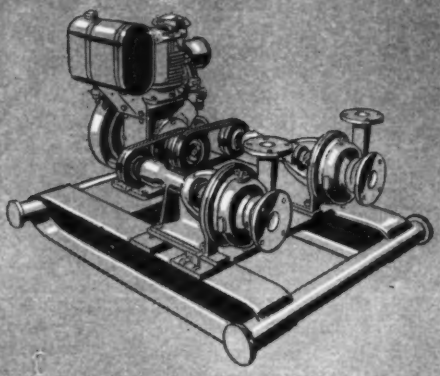
PEERLESS PUMPS fmc

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION
Address inquiries to Factories at
Los Angeles 31, California and Indianapolis 8, Indiana
Offices: New York, Chicago, St. Louis, Atlanta, Dallas, Plainview and Lubbock, Texas; Fresno; Los Angeles; Phoenix; Albuquerque, N. M.

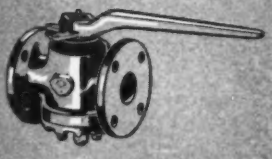

Pipe
AMPCO*
ALUMINUM BRONZES
Conveyor Screws
Heat Exchangers
Centrifugal Separators



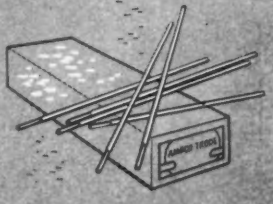
Bubble caps



Ampco Centrifugal Pumps



Ampco Plug Valves



Ampco Bronze Electrodes

Ampco Pipe Fittings

an answer to corrosion problems!

Boiler Code Approval

Ampco Metal Grade 8 is an annealed alpha aluminum-bronze alloy conforming to ASTM B-169-50T Alloy D. It is approved for use in the construction of unfired pressure vessels. See your Boiler Code Handbook — paragraphs U-68 and U-69 as interpreted in case No. 1108 — for complete details.

*Reg. U. S. Pat. Off.

Ampco Metal, Inc.
Milwaukee 46, Wisconsin
West Coast Plant,
Burbank, California

AMPCO®

Tear out this coupon and mail today!

AMPCO METAL, INC., Dept. PP-11 Milwaukee 46, Wis.

Send me information on the application of Ampco Aluminum Bronzes for corrosion-resistant service in the Process Industries.

Name ..... Title .....

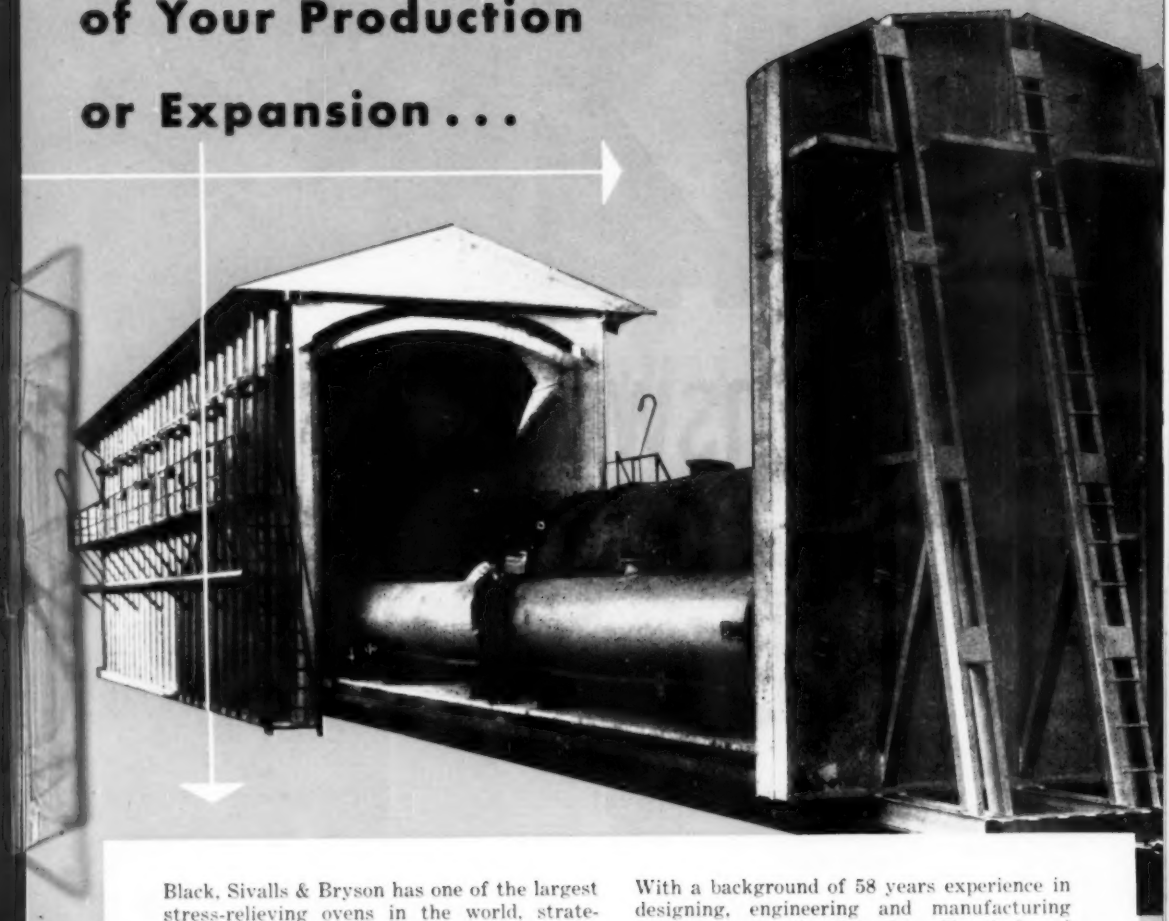
Company .....

Company Address .....

City ..... ( ) State .....

PR-5

To Relieve the "STRESS" of Your Production or Expansion . . .



Black, Sivalls & Bryson has one of the largest stress-relieving ovens in the world, strategically located at Oklahoma City. If you are planning expanded facilities, increased or diversified production, new special equipment, consider what the capacity, speed and efficiency of this huge metal-treating monster can mean to you — in savings of investment, production costs and time. Yet this oven is only *one* of the many BS&B facilities available for the fabrication of your large weldments, pressure vessels, or other metal products required by your plant.

With a background of 58 years experience in designing, engineering and manufacturing equipment for the Oil, Gas, Chemical and other processing industries, BS&B has the engineering and laboratory staffs to assist you with design and metallurgic problems; plus the precision manufacturing facilities and quality control methods for efficient, economical fabrication.

If your requirements can be served in the Midwest, why not let us see if BS&B's varied facilities can assist you? Your inquiry is treated in strict confidence.

BS&B — EFFICIENCY RELIABILITY

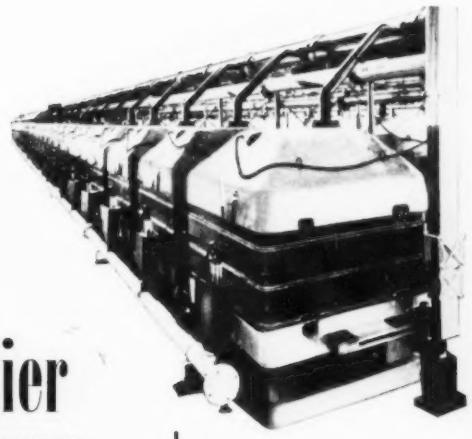
Write Dept. 90-D

BLACK, SIVALLS & BRYSON, INC.

7500 East 12th Street *Kansas City, Mo.*

BS&B plants in: Kansas City • Oklahoma City • Tulsa

Hooker Chemicals stem from the Type "S" Cells at Niagara Falls and the high-capacity Type "S-3" Cells at Tacoma. In these cells, the highly efficient electrolysis of salt brine produces raw materials of high purity and constant uniformity, in quantity, for use by more than 30 U.S. industries.



HOOKER - basic supplier of INTERMEDIATES...

These Hooker Chemicals are widely used as intermediates by many process industries.

Starting point for all Hooker intermediates is the highly efficient Type "S" Cell. Used by Hooker and by many licensees, the "S" Cell has increased the domestic production and commercial supply of these and other chemicals.

Hooker serves you with strategically located plants and distributing stations; careful control of shipments; skilled customer service. This well-balanced supply "package" has pleased many users.

For the complete list of Hooker Chemicals, send for Bulletin 100. For properties, specifications and uses of any chemicals listed here, ask for Technical Data Sheets. Please request them on your business letterhead.

- Benzal Chloride
- Benzoic Acid
- Benzotrichloride
- Benzoyl Chloride
- Benzyl Chloride
- Chlorobenzenes
- Chlorotoluene
- Lauryl Chloride
- Monochloroacetic Acid
- m-Nitrobenzoyl Chloride
- p-Nitrobenzoyl Chloride
- Phenyl Isocyanate
- Sodium Benzoate
- Sodium Sulfhydrate
- Thionyl Chloride

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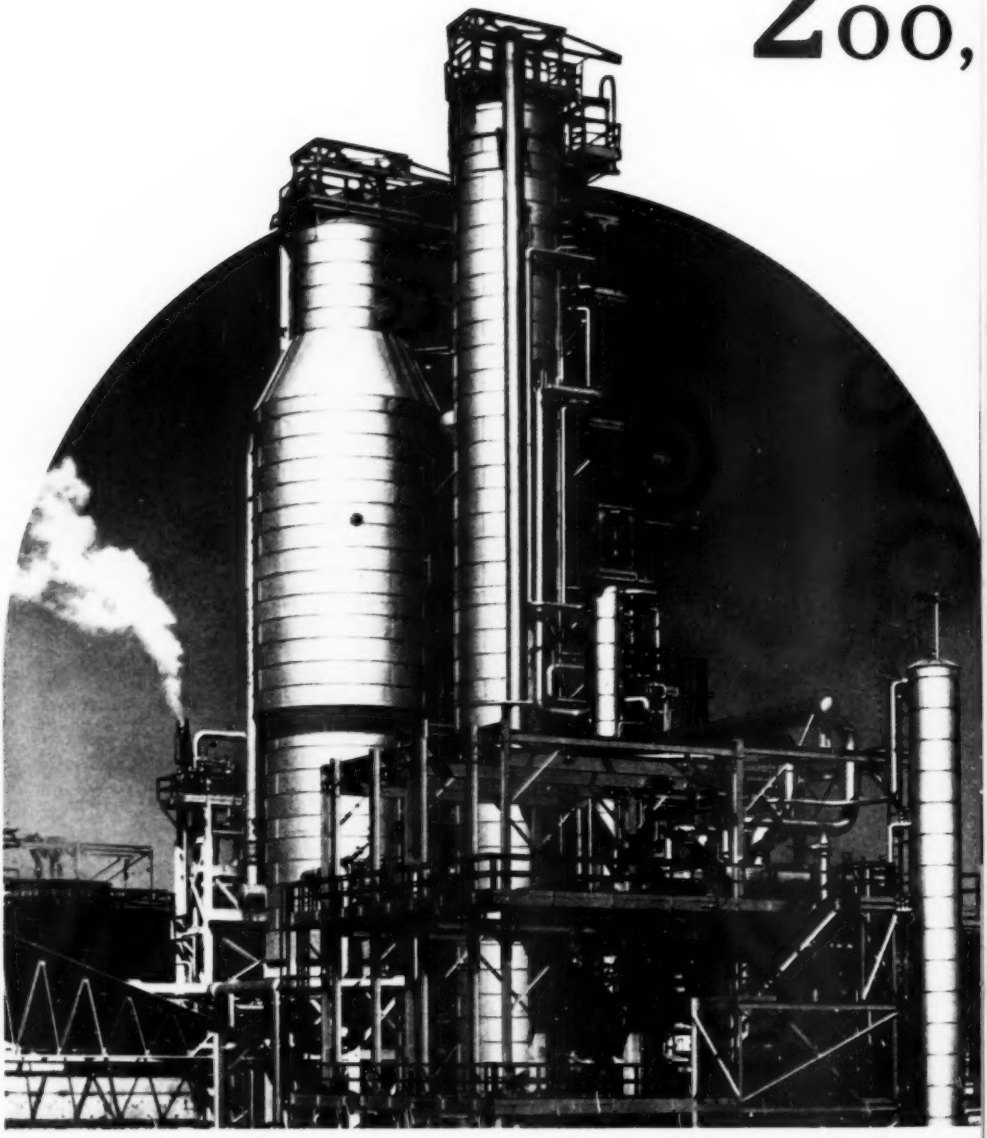

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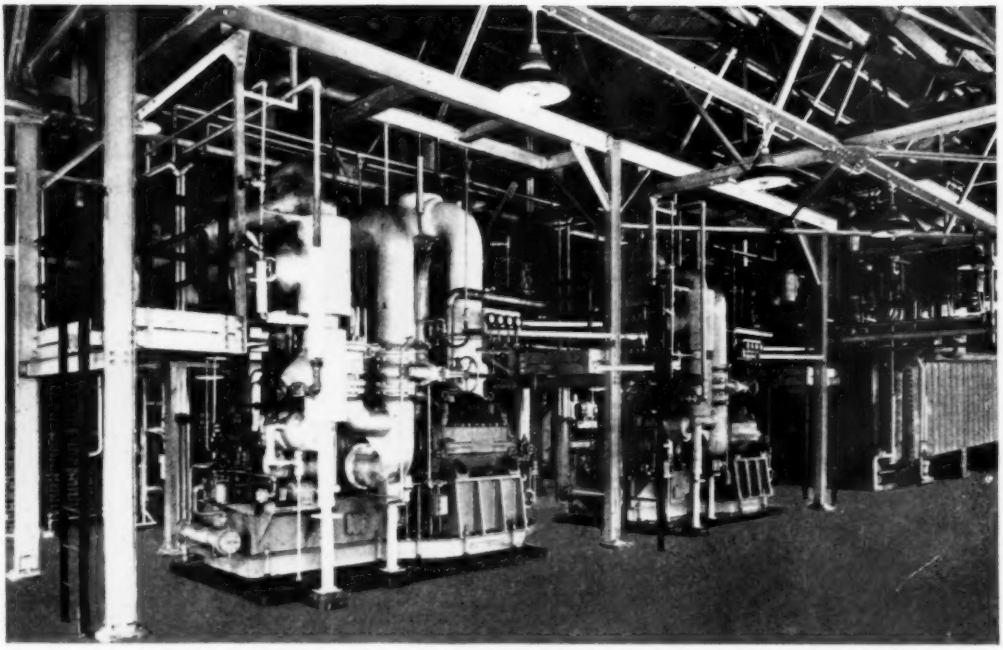

Two Worthington centrifugal compressors, each capable of handling the full 380-ton load; at right, one of the three Worthington chilling machines.

How Socony-Vacuum Gives Wax the Cold Shoulder

For the new addition to its Paulsboro refinery, Socony-Vacuum and its process engineers and constructors, E. B. Badger & Sons Co., found the *right* chilling equipment in Worthington's complete line.

Here's how this modern plant meets the 380-ton refrigeration load required by its solvent dewaxing process.

Plant propane is alternately condensed and vaporized in a closed cycle. The liquid propane, boiling at a low pressure and a constant temperature of minus 25F, surrounds the tubes in the Worthington inclined chiller through which the wax-bearing mixture is pumped.

Propane vapor, released in the chiller, is withdrawn to be compressed, with two liquid intercooling stages, from suction conditions of about 8 psig to a condenser pressure of 215 psig.

The compressors are four-stage Worthington centrifugal compressors. They are driven by 8420 rpm Worthington steam turbines which take steam from the plant mains at about 400 psig and exhaust at 40 psig back pressure to be used for heating purposes in other parts of the solvent recovery process.

Important installations such as this one are most likely to include Worthington refrigeration, because Worthington offers complete cycles for petroleum, chemical and petro-chemical applications, including centrifugal charge gas compressors for high pressure, condensers, coolers and exchangers.

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PETROLEUM CHEMICALS DIVISION
NEWS

November ★ One of a Series of Interest to the Petroleum Industry ★ 1951

WHAT IS TEL?

Motor fuel antiknock compound is made by blending various halogen carriers, dye and kerosine with tetraethyl lead.

When used in an internal combustion engine, tetraethyl lead by itself would form nonvolatile decomposition products which would deposit on the cylinder head and other surfaces of the combustion chamber. To reduce the deposition tendency of these products by increasing their volatility through chemical reaction, scavengers in the form of ethylene dichloride and ethylene dibromide are added. The proportion in which these scavengers are employed is determined initially in laboratory engines and proof-tested in extensive road tests in commercial equipment under actual operating conditions.

Sufficient dye is added to give a distinctive color to the mix as all the other ingredients are colorless or water white. Kerosine in limited amount is used as a standardizing agent to insure uniformity of TEL content in the mix. It is a stable product up to 330°F. but begins to decompose above that temperature.

Du Pont GAS GUARD prevents fuel line freezing

Du Pont Gas Guard is another product designed to help motorists get better car performance. Gas Guard helps prevent ice from forming in gasoline lines of autos, trucks and tractors.

Cold-weather engine stalling, spitting and sputtering due to the presence of water in gasoline can also be prevented by Du Pont Gas Guard. By keeping the system ice-free, it contributes to quicker starting and smoother engine performance, even in sub-zero weather.

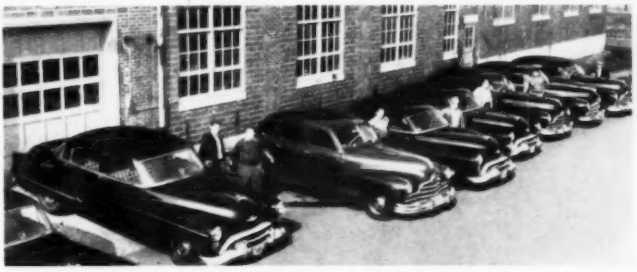
One pint of Du Pont Gas Guard in 15 gallons of gasoline, for example, will prevent freezing of as much as 10 ounces of water at 30° below zero F. During moderate freezing and zero weather, a pint of Gas Guard every 1,000 miles of driving will give adequate protection.

It is also highly effective as an antifreeze in diesel fuels. At −24° F., one pint of Gas Guard in 10 gallons of diesel fuel will keep 14 ounces of water from freezing, thus preventing crystals from clogging the jets.

It is harmless to the carburetor, fuel pump and other engine parts when used as directed. Du Pont Gas Guard is distributed in pint cans through service stations, garages and car dealers.

Du Pont Test Fleet Accumulates Deposit Data Under Actual Traffic Conditions

WHEN Du Pont engineers undertook a study of engine deposits and their effect on octane requirement, they determined to make certain that the findings would be of practical value to refiners. To study only the deposits built up in laboratory engines was not enough.



READY FOR A DAY'S TEST RUN, the four Oldsmobiles and four Pontiacs used in the deposit studies are shown with their drivers in front of the Du Pont test fleet garage.

These engineers wanted the study to be truly representative of the deposits accumulated in the average car, powered by average gasoline, under average traffic conditions. But how could they be sure the deposits from any given auto engine would be representative? The Du Pont test fleet provided an answer.

A test course approximating typical highway and city driving conditions was set up. About 64% of the course was through downtown Philadelphia traffic. The remainder over nearby country roads.

Starting with deposit-free engines, eight cars were driven over the course daily until a total of 8,500 miles was recorded on each car. Four of the cars were 1950 Oldsmobile 98's with hydromatic transmissions. The other four were 1947 Pontiac 8's with 1948 engines and standard transmissions.

Before starting the test, each car was road-checked for gasoline mileage, acceleration time and octane requirement. The engines were not "doctored" in any way. Each was tuned up according to the manufacturer's standard specifications . . . and kept that way until completion of the test. To assure uniform operation, distributor settings were constantly checked throughout the test.

The fleet was set up in pairs of cars. Each pair used identical fuels and lubricants. This made it possible for the performance of one car to be checked against that of its identical mate . . . an additional assurance of uniform engine performance.

The cars were operated as a group, although no attempt was made to maintain exact formation in heavy traffic. The city course was covered several times each day. This helped to vary the traffic density conditions and the amount of start-and-stop driving . . . with each car encountering about the same conditions during a day's run.

The cars were equipped with recording tachographs to give an accurate account of their individual operations.

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OVER

DU PONT

PETROLEUM CHEMICALS DIVISION
NEWS

DU PONT

CONTINUED Test Fleet

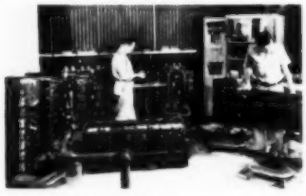
These instruments helped supply many valuable statistics. For example, they showed that during a 5-day period the average number of stops per car per 8-hour shift was 328. And all these stops occurred in an average of 101 miles of operation.

Sixteen drivers, working two shifts, participated in the test. To control the driver effect, the men were alternated so that each car was driven approximately the same time and mileage by all drivers.

A driver-leader was in charge of each shift. The leaders were responsible for the safe performance of the fleet in the field.

Driving safety and courtesy is emphasized in all Du Pont test fleet operations. In addition to turning in an excellent safety record, the fleet drivers were able to help several motorists in trouble on the road. For example, since all test cars carried fire extinguishers, the Du Pont drivers were in a position to put out a number of highway auto fires which might otherwise have been both hazardous and damaging.

At 8,500 miles the test car engines were taken down and the quantity and composition of their deposits investigated. As was expected, much new information was gained from the test. This, along with other data, was evaluated at the Du Pont Petroleum Laboratory and the results are now available to refiners in a paper recently published. This paper was presented by L. F. Dumont of the Petroleum Laboratory staff at the June S.A.E. meeting in French Lick, Indiana. Reprints of the paper with the title, "Possible Mechanisms by which Deposits Accumulate and Influence Knock" are available on request.



THE TWO DRIVER-LEADERS are also trained mechanics. Here they are inspecting the torn down engines of the eight cars used in the recent Du Pont deposit studies.

Du Pont test fleets constantly work on road tests of this type. In addition to the one described above, a 5,200 mile test with "dirty" fuel has just been completed. And another deposit study is now being made with the Du Pont heavy-duty truck fleet in El Monte, California.

Assistant Director of Petroleum Laboratory

W. E. BETTONEY

W. E. Bettoney was appointed Assistant Director of the Du Pont Petroleum Laboratory in June of this year. In this capacity he directs work on combustion chamber deposit studies and other petroleum research projects. He is also in charge of test fleet operations. Previous to this assignment, Bettoney headed the Engineering Division of the Laboratory.

He came to Du Pont in 1946 from Universal Oil Products. With the Chrysler Corporation during World War II, he worked on the development of B-29 engines at the Dodge Chicago plant. Before this, Bettoney spent three years as a government test engineer on full-scale experimental airplane engines at Wright Field.

He graduated from the University of Maine with a B.S. in mechanical engineering and did graduate work at Columbia and New York Universities.

New TEL Blending Chart for Laboratory Convenience

A reference chart for blending Du Pont Tetraethyl Lead Compound—Aviation Mix with small quantities of gasoline is now available to refiners. It was prepared by Du Pont to aid laboratory personnel in the leading of test fuels and samples.

In table form, the chart shows the number of milliliters of Du Pont Aviation Mix required for fuel samples from 1 to 20 liters and from 0.1 to 100 gallons. Any desired concentration from 0.1 to 6.0 ml TEL/gal. can be prepared from the table.

In addition, information on the properties, composition, conversion factors and dye concentrations of Du Pont TEL Aviation Mix is included on the reverse side. Ask the nearest Du Pont district office or write direct to Du Pont for your copy.

MOVIES AVAILABLE

Prints of the following Du Pont films are available to oil companies for training and public relations purposes. They may be borrowed or purchased. Address request to nearest Petroleum Chemicals Division district office.

Pipeline on Wheels—A 26-minute, full-color movie on tank truck safety. Suitable for both training and public relations purposes.

What Makes A Gasoline Good—An 18-minute cartoon movie in color. Presents the story of how high quality gasoline is made in easy-to-understand form. Ideal for dealer training meetings.

In addition to the above, Du Pont makes available a special library of films of particular interest to the petroleum industry.

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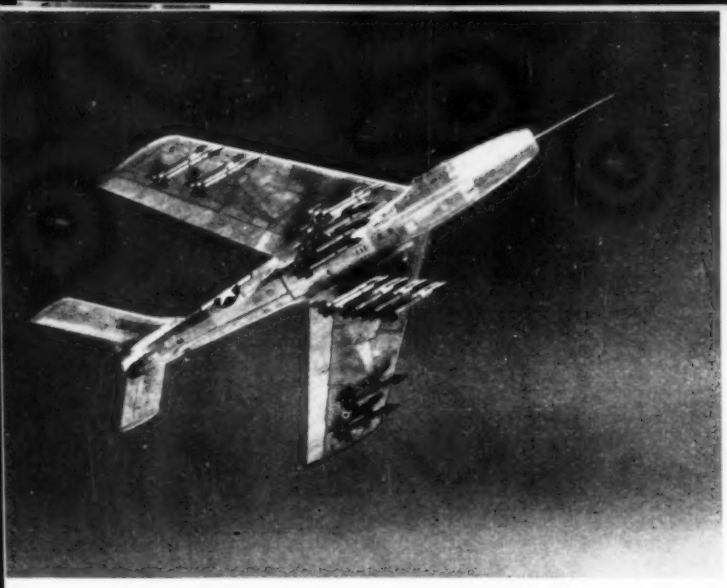


ONE OF THE NEWEST JET Fighters for U. S. Air Force, the Republic designed and built **F-84F**

Defense Dept. Photo (U. S. Air Force)

Jet Fuel Quality Requirements

What must the refiner know to make them?

By D. P. BARNARD
Standard Oil Co. (Indiana)

THE aviation jet engine has now come into wide military use, particularly where high power is needed, and also where starting at very low temperatures is necessary. The jet, either alone or in combination with a turbine-driven propeller (the "turboprop"), is well adapted to these requirements. In marked contrast to the piston engine, jets become relatively easier to build as the size increases, and they lack the large areas of sliding surface that make piston engines hard to start at extremely low temperatures.

The pure jet is especially well adapted to high-speed flight. As speeds increase, the thrust efficiency of its high-velocity discharge also increases, whereas the thrust efficiency of a propeller decreases at speeds above 500 mph. The turboprop combination is of course limited in speed by its propeller but offers considerable promise for large transports and for certain special-purpose military aircraft in which large unit powerplants are needed. Because of the complex problems of gearing and propeller design, particularly propeller pitch control, the turboprop is not used at present to anything like the extent of the pure jet. Some authorities believe it never will occupy a major place in the picture—that by the time it can be fully developed, the jet will also have been refined to the place where it will largely cancel the need for the big propeller-type powerplant. So far as fuel is concerned, however, this uncertainty need not worry us; the combustion systems for the pure jet and the turboprop are essentially the same.

With any type of jet engine, the chief fuel problem is consumption. The appetites of these powerplants are truly enormous—mainly because of their sheer size, but partly because of their high fuel requirements when idling. The compressor draws in from four to six times as much air as is required for combustion. A considerable amount of fuel energy must be used in pumping this air, even when thrust is reduced to the so-called idle condition. Many jet engines consume around 30% as much fuel at idle as at full thrust.

Even under the most favorable conditions, present jets and jet combinations do not have good fuel economy. Most require on the average more than one lb. of fuel per hr. for each lb. of thrust developed. The very latest ones—particularly the J-57—can get along on something less, but a fuel consumption of 0.9 lb. of fuel per hr. per lb. of thrust (static) is about their best figure. For an engine of 10,000-lb. thrust, this may at times reach 9,000 lb. per hr., although cruising at altitude will normally be nearer half this rate. (At high speed and altitude, the fuel consumed per lb. of thrust will increase by about 20%, instead of decreasing.) Such fuel consumption rates may or may not be extravagant, depending on the speed attained. At 375 mph., one lb. of thrust is equivalent to one net thrust hp. actually developed, and fuel consumption would be 0.9 lb. per hp. hr.—roughly double the consumption per thrust hp. hr. of a large modern piston engine and propeller when operated near its point of best economy. At 750 mph., however, the increased thrust efficiency of the jet discharge would result in a fuel consumption of only about 0.55 lb. per net thrust hp. hr. While this is somewhat higher than the fuel consumption of large piston powerplants operating under their most advantageous conditions, it is not too bad and is defi-

Table 1—Jet Fuel Requirements, for Grades JP-3 and JP-4, as Specified under MIL-F-5624A, May 23, 1951

Properties	JP-3	JP-4
Freezing point, not higher than	—60°C (—76°F.)	—60°C (—76°F.)
Corrosion ("Air-Well" Copper Strip)	No evidence of corrosion and, after 3-hr. test period, not more than slight discoloration of the copper strip	
Residue, after evaporation by air jet method, not greater than	10 mg./100 ml.	10 mg./100 ml.
Aromatics, not to exceed	25%-vol.	25%-vol.
Total sulfur, not to exceed	0.4%-wt.	0.4%-wt.
Gravity, minimum, °API	45	10
Gravity, maximum, °API	63	58
Reid vapor pressure, @ 37.8°C (100°F), min.	5 psi.	2 psi.
Reid vapor pressure @ 37.8°C (100°F), max.	7 psi.	3 psi.
Water tolerance	Substantially immiscible with water. Fuel & water layers to be clear & sharply defined; neither to change in color or volume by more than 1 ml.	
Accelerated gum content, not over	20 mg./100 ml.	20 mg./100 ml.
Distillation range:		
10% evaporated, min., at	———	121.1°C (250°F)
90% evaporated, max., at	204.4°C (400°F)	———
End point, max.	315.5°C (600°F)	287.8°C (550°F)
Residue, not to exceed	1.5%	1.5%
Loss, not to exceed	1.5%	1.5%
Bromine number, not to exceed	30.0	30.0
Inhibitor: Following may be added separately or in combination to the fuel in total concentration not over 1 lb. (not including wt. of solvent) per 5000 U. S. gals. of fuel to prevent gum formation	2,6-Ditertiary Butyl 4-Methyl Phenol N, N' Di secondary Butyl Paraphenylenediamine 2,4-Dimethyl-6 tertiary-butylphenol	
Heat of combustion, net value not less than	18,400 Btu./lb.	18,400 Btu./lb.(1)
Mercaptan sulfur, not to exceed	0.005%-wt.	0.005%-wt.(2)
Workmanship	Fuel shall be free from undissolved water, sediment, and suspended matter. Odor not to be nauseating or irritating. No substance of known dangerous toxicity under usual conditions of handling and use shall be present.	

(1) Heat of combustion determination may be waived at the option of the Inspector if the aniline gravity constant is not less than 5,200 (product of API gravity and aniline pt. in °F.)
(2) Mercaptan sulfur determination may be waived at the option of the Inspector if the fuel is considered "sweet" when tested in accordance with the Doctor test of Specification VV-L-791.

nitely lower than would be required at such speeds by any known powerplant involving the use of a propeller.

It is apparent, therefore, that on a fuel consumption basis, the jet is justified only when high speeds are required. High in this case means 500 mph. and faster. In spite of the apparent drawbacks, the virtues of the jet and the turboprop for high powers and high speeds are such that they offer by far the most attractive field for further development, particularly for military use.

Fuel Properties

Jet fuel specifications can be best considered in the following order:

1. Calorific value
2. Specific gravity
3. Distillation
4. Aromatic content
5. Reid vapor pressure
6. Freezing point
7. Copper strip corrosion
8. Air-jet gum
9. Potential gum
10. Sulfur
11. Inhibitor content
12. Bromine number

Actually, the major performance effects end at the sixth item—freezing point—although excessive corrosion or gum will of course interfere with the operation of the fuel system.

The effects of these features on overall engine and aircraft performance fall into three principal categories:

1. Engine behavior.
2. Fuel system operation.
3. Airplane range and weight.

Problems of Engine Behavior

Combustion Efficiency—Because the fuel requirements of any jet powerplant are large, combustion efficiency is particularly important, and requires careful consideration in the fitting of the fuel to the engine. No combustor yet developed can burn with high thermal efficiencies fuels varying over too wide a range. Combustors designed to give best performance on aviation gasoline work less well on kerosine.

The fuel characteristics most directly influencing combustion efficiency are volatility and hydrogen-carbon ratio. As might be expected, fuels that are too heavy for the spray system and for the combustor design do not burn as well as more volatile fuels. Low hydrogen-carbon ratios also interfere with combustion efficiency, although even straight aromatics have actually been handled in specially adapted burners and have shown some evidence of improved flame stability at high altitude. The effect of aromaticity or hydrogen-carbon ratio is related to volatility; light aromatics are less objectionable than heavy ones.

Combustor Carbon—Carbon formation is tied closely to combustion efficiency and is influenced by the same fuel characteristics: volatility and hydrogen/carbon ratio. In spite of the fact that the internal air-cooling required to protect the turbine forces both types of turbine-equipped jets to operate at high air/fuel ratios (varying from around 60 to 1 rich to over 100 to 1 lean), carbon formation is a real problem. There is a marked similarity between carbon formation in the combustor and in the pot-type domestic heater. Almost any logical scheme for recognizing paraffinicity and volatility seems to give a fairly good picture of the carbon-forming tendency of a fuel.

Flame-Out at High Altitude—Rich flame-out is the vernacular for combustion failure due to oxygen deficiency in the primary combustion zone. All gas turbine combustors depend on substantially complete combustion in the primary zone, and prompt cooling of the gases by large amounts of secondary air. This cooling immediately following the combustion zone is necessary for two reasons:

1. To protect both the combustion chamber and the turbine rotor, which cannot endure temperatures much above 1500° F. at the high stresses necessarily involved.

2. To improve the thrust efficiency by increasing the volume and decreasing the speed of the exit gases, so that they leave the tail pipe at a velocity closer to the speed of the airplane itself.

In some respects, the jet-propelled aircraft resembles the propeller-driven airplane or boat. Too much "slip" between the backward velocity of the propelling medium and the forward motion of the vehicle results in an intolerable loss in thrust efficiency. Thrust efficiency would be 100% only if the vehicle moved forward at exactly the velocity of the issuing jet. The best compromise involves substantial backward motion of the jet stream, but this disparity cannot be permitted to become too great. The large amounts of cooling air drawn through the turbine therefore not only protect its structure but also improve the efficiency of the propulsion. At the limiting altitudes reduced air density requires such a reduction in fuel supply—in order to preserve the very high air/fuel ratios characteristic of internal air cooling—that the powerplant fails as the result of insufficient energy release. Much design progress has extended the altitude limits of the aviation turbine, but as yet no close relationship has been established with fuel properties.

Lean Flame-Out—Lean flame-out occurs when too little fuel is present, and becomes most critical under idle or greatly reduced power conditions. The heavier aromatics seem harder to handle than the lighter and more

paraffinic fuels, but lean-mixture failure has not yet been tied closely to any particular fuel property. Uniformity gives the designer the best chance to arrange things so as to get maximum reliability.

Restarting at Altitude—In starting any jet powerplant equipped with a turbine, much more power is required than for a piston engine of similar output. In general, about ten times the amount of starter horsepower is needed to get the jets going. This is largely because of the high compressor speeds necessary in order to pull enough air through the system to make the combustion self-supporting. At very low atmospheric temperatures starting may become impossible with the fuels normally used in operation. Present practice in Arctic starting is to use priming fuels of the LPG variety.

Restarting an engine that has been stopped while in flight at high altitudes can also be difficult, particularly where the airplane is operating on the higher-flash fuels. One reason for the present minimum Reid vapor pressure specification is to facilitate such restarting. Here, of course, the cranking problem is not serious; windmilling of the compressor (particularly of the axial type) is usually sufficient. However, reliable starting at altitude is a "must" for long-range military aircraft. Attainment of maximum cruising range may necessitate shutting down some powerplants, with the implication of prompt restarting when required. This is particularly true in the present version of the B-36; although equipped with piston-type engines, it carries four auxiliary jets to provide extra speed in the target area.

Effect of Chemical Characteristics—The jet powerplant is not affected by molecular configuration of the fuel; it is not subject to the knocking that occurs in the piston engine or to the ignition delays that occur in the diesel. To date, the turbine has shown no requirements analogous to octane number or cetane number characteristics. It seems to be aware of only two major features—calorific value and ability of the fuel to burn without leaving excessive residues in the combustion zone.

It is possible for a turbine fuel to contain contaminants, particularly sulfur, which might adversely affect either combustor liner or turbine bucket materials. Thus far, sulfur has not been a serious problem. Combustor liners are necessarily constructed of high-nickel alloys. Such materials are not seriously affected by sulfur dioxide, though they would be subject to rapid corrosion if any hydrogen sulfide or elemental sulfur should come in contact with them at high temperatures. The air/fuel mixture within the combustor is generally so lean, however, that no H_2S can exist. Even high nickel alloys are not appreciably affected, although some primary zone trouble has been reported with 0.45% sulfur.

Vanadium salts exist in residual fuels, and would adversely affect turbine construction materials. However, fuels meeting the other requirements of aircraft operation are distillates and so should be free of vanadium compounds.

Fuel System Operation

Fuel Metering—Because the ability of metals to withstand high stresses at high temperatures is the principal limitation to the output of jet engines, the most practical method of controlling fuel rate is to tie it in with tailpipe temperature. The older forms of the engine have been in the main equipped with volumetric fuel metering systems governed only by controls responsive to atmospheric pressure. The purpose is to prevent the introduction of too much fuel at high altitudes, where the weight of air taken in is markedly reduced. This system requires the pilot to keep his eye on an indicator in order to avoid tailpipe temperatures that might damage the powerplant. In the newest engines, the control systems are directly tied in to tailpipe temperatures, and relieve the pilot of this responsibility. Obviously, the differences in the calorific value of the fuel will show up as corresponding differences in fuel rate required to maintain a given powerplant output or, in more practical terms, a given tailpipe temperature.

Vapor Loss and Slugging—The problems of vapor loss and the slugging of liquid through the fuel-tank vents are very serious in the operation of high-performance military aircraft. The jet-powered interceptor must be able to climb at high vertical rates. A gain in altitude of well over two miles a minute is normal. The reduction in air pressure would produce boiling with fuel of 7-lb. Reid vapor pressure, particularly if well warmed up from protracted standing under a hot sun. To handle 7-lb. fuel under such conditions would require either refrigeration or pressure. Refrigeration has not been found practicable, and there are many objections to pressurizing, particularly in combat aircraft.

The main losses that occur are not due to simple evaporation. High-speed aircraft are so cramped for space that the tanks cannot be adequately designed for disengagement of vapor from liquid. Rapid increases in vapor formation frequently result in "slugging" losses which may exceed 20%. Such losses are intolerable, and vapor pressures lower than 7 lb. are needed to minimize the difficulty. Specification for grade JP-4, recently issued, provides that the Reid vapor pressure shall be held between 2 lb. min. and 3 lb. max. (See Table 1)

Fuel Freezing — Military airplanes may be required to operate under Arctic winter conditions. This involves being parked outdoors and becoming "cold-soaked" at air temperatures that sometimes reach —65° F. Also, engines may be shut down in flight, with consequent danger of the fuel freezing in the lines. For this

Meet the Author

Daniel P. Barnard

Dr. Daniel P. Barnard IV, research coordinator for Standard Oil Co., Indiana, was born June 26, 1898, in Wilmington, Del. He attended the University of Delaware and then received the degrees of master and doctor of science in chemical engineering at M.I.T. After three years in the research laboratory of applied chemistry at M.I.T., he joined Indiana Standard in 1925 as assistant director of research to establish the company's automotive research laboratory at the Whiting refinery. In 1938, Dr. Barnard became associate director of research, and in 1945 he was transferred to the main office in Chicago. He became research coordinator in 1948.

Dr. Barnard received the 1949 Horning Memorial Award from the SAE "in recognition of distinguished service in the field of mutual adaptation of fuels and engines." In 1949 and 1950 he was president of the Coordinating Research Council, having served with its predecessor, the Co-operative Fuels Research committee, since 1923. He was chairman of the automotive research committee of the API refining division in 1949 and 1950. Since 1940, Dr. Barnard has been a member of the subcommittee on aircraft fuels of the National Advisory Committee for Aeronautics.

reason, the freezing-point specification of −76° F. is essential to the functioning of military aircraft. However, it is not yet considered necessary for fuels used by jet-powered civil aircraft.

Pumpability at Low Temperatures—Viscosity is important from two principal standpoints:

1. If the viscosity is too high, the pumping system in the aircraft may not be able to cope with it.

2. To the extent that water crystals or other solids may be present in the fuel, they tend to be kept in suspension and to be carried to the strainers where they may cause clogging.

The general experience is that water and solid contaminants are less serious in low-viscosity fuels (such as gasoline) than in the heavier fuels. If viscosities can be kept low, these practical operating problems can be minimized.

Corrosion—Such corrosion as has been encountered in the fuel system has been principally due to mercaptan sulfur. Attack has focused on cadmium-plated and some bronze parts, and in a few instances synthetic seals have suffered as well. Naphthenic acids have also given some difficulty. The present opinion is that mercaptan sulfur should be limited to 0.005%, and that it may be necessary to require complete removal of naphthenic acids. Tests to evaluate these factors are as yet incomplete.

Gum—To date, gum has not proved as important a problem with jet fuels as with gasolines. The jet contains no counterpart of the piston engine's induction system, in which liquid fuel evaporation results in deposition of solids or gummy materials at points of interference. If gum or other resinous materials were precipitated, they would of course tend to clog filters and adversely affect the performance of pumps or spray nozzles; however, 100 mg. or even more has shown no harmful effects.

In all probability, the jet-fuel gum problem is analogous to similar problems with other distillate fuels. It becomes primarily one of storage stability, with the possible added complication that the military fuel may undergo protracted storage at high or low temperatures in comparatively small containers. Also, there may be more mixing of fuels from different sources than occurs in commercial operations. At present, the specifications contain two provisions involving gum. One is an air-jet method for determining existing gum; the other amounts to translation of the 16-hour oxygen bomb stability test from the aviation gasoline specifications. This latter test for all practical purposes rules out cracked components. Obviously a more appropriate test must be developed if unwarranted restrictions to availability are to be avoided.

Aircraft Performance

Fuel Load—Present fuel specifications, combined with operating procedures, permit differences in volumetric heating value of as much as 15%—too much to be ignored. This corresponds to the use of JP-1, JP-3, or 100-octane gasoline. In actual practice, the situation may not be nearly so bad. The Navy may have only gasoline on its carriers, and operation on this fuel will remain reasonably consistent. Land-based operations may be more complex.

Specific gravity may vary by more than 6%, with corresponding fluctuations in volumetric heating value. Many discussions have been held about the relative importance of volumetric and weight calorific values. It has been maintained that high-speed aircraft are volume limited, and that maximum range therefore requires maximum caloric value *per gallon*. A recent study has pointed out, however, that increased "down wash" drag losses, which necessarily accompany increased total airplane weight, would just about equal the increase in parasitic drag that would result from the use of larger wing tip tanks.

No matter how thoroughly an airplane may be engineered, the military operator will find ways to load it beyond original design limits. An example is the droppable wing tank. So long as these fuel tanks are used, there is no such thing as a truly volume-limited aircraft. Differences in fuel specific gravity can be compensated merely by varying the capacity of the droppable tanks. Just what fuel density variation can be tolerated is not well known, but it would seem a fairly safe assumption that the present possible variation of 6% should be materially reduced.

Other Properties

In the foregoing discussion, jet fuel characteristics have been treated as they currently appear to affect aircraft performance. The specifications list additional features, such as inhibitor content and bromine number. These are considered to bear no close relation to either utility, performance, or storage behavior. The net effect of the 16-hr. accelerated gum test, plus the bromine number requirement, is to limit composition to virgin stocks. Experience and logic indicate that this should not be necessary. Fuels stable under actual storage conditions (and which can be expected to burn satisfactorily in other forms of equipment) should be satisfactory for aircraft. As a matter of fact, solution of the various low-temperature problems would probably be aided by the use of stable cracked stocks and the more volatile aromatics.

In all probability, jet fuel specifications will be modified to permit the use of a wider range of distillate fuel stocks. When this is finally worked out, the resulting specification should permit combinations of hydrocarbon type, volatility, and other salient properties that will enable the refiner to manufacture the fuels on a more efficient basis. At the same time, the new specifications should narrow the permissible variation in the factors that do affect performance.

If War Comes, How About Quality of other Products?

LARGE-scale wartime production of jet fuels may, under some circumstances, have an effect upon the quality of some civilian products. However, gasoline should not be among them.

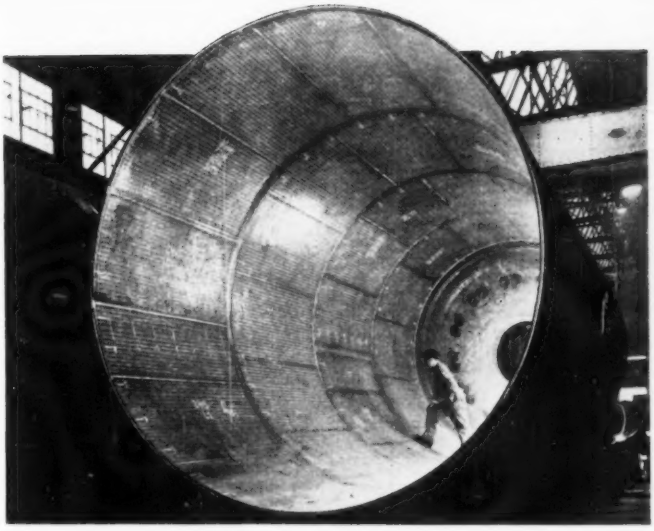
This point was among those brought out by Thomas L. Apjohn, assistant director, refining division, PAD, in a talk before a recent regional meeting of the Western Petroleum Refiners Ass'n. in Alma, Mich.

"The gasoline fraction used in jet fuels need not be high in antiknock quality," Mr. Apjohn explained. "In fact, better engine performance would probably be obtained from low octane number straight run stocks. Now that Grade 115-145 has largely supplanted Grade 100-130 as a reciprocating engine fuel, overall demand for a superior quality base stock will probably be lower in any future war than it was in World War II. Catalytically reformed stocks will contribute heavily to the avgas base stock demand.

"These factors, together with the marked increases in catalytic cracking capacity that have been accomplished during the last six years, should mean that wartime aviation gasoline and jet fuel production levels will have a negligible effect on motor gasoline quality. However, a substantially reduced *quantity* would be available."

Probable effects on distillates are not as clear cut. Jet fuels of JP-4 grade could include as much as 35% of hydrocarbons normally in light fuel oil range, it was said. Without sufficient crude or processing facilities at time of high demand for jet fuel, refiners would have to manufacture lower volatility Diesel fuels and heating oils and generally lower quality kerosine.

The problems associated with extended volatility range in Diesel fuels is now under study by the Association of American Railroads and some of the oil companies.



LINING TOWERS for corrosion protection is good practice—if you use the proper alloys. In this fractionator, 18-8 has been put over the bottom section, Monel over the top dome.
Photo courtesy A. O. Smith Corp.

Selecting Alloys to Resist Corrosion

Corrosion in petroleum refineries is broadly classified as that occurring in equipment operated at above 500 F., and at below 500 F. Corrosion occurring under the latter temperature conditions is often more difficult to handle because it is electrolytic in type. Types of alloys are described which are resistant to high temperature corrosion from sulfur and organic acids and solvents. Protection of equipment in some of the newer refining methods, including solvent lubricating oil manufacture, is discussed.

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CORROSION occurring in a petroleum refinery permits broad classification upon a basis of temperature. In general, 500° F. marks the boundary between the types. Above 500° F. corrosive attack can be expected within equipment from sulfur and in some cases from organic acids as naphthenic acids liberated from crude oil, or from phenol or furfural where these solvents are used. Chlorine is another reagent that will attack some metals at elevated temperatures. Oxidation outside of equipment is sometimes a factor that must be considered at elevated temperatures.

Below 500° F. water may exist and the corrosion becomes electrolytic in type. Combating this type of corrosion presents more difficulties than is experienced in combating corrosion above 500° F.

High Temperature Corrosion

In the discussion under this heading, the temperatures considered are in excess of 500° F.

Sulfur Attack: Sulfur attack and also oxidation of steel is retarded by additions of chromium to the composition. The benefits of chromium increase with the amount added, up to about 28%. The most marked improvement in resistance of steel to sulfur attack and to oxidation occurs with the first additions of chromium, up to 4 or 5%. The knowledge of this fact is reflected in the widespread use of the 4-6% chrome tubes in fired coils. An addition of molybdenum of ½% is made to inhibit temper-brittleness in the chromium-iron alloy. Where the chromium content is increased to 7 or 9%, the molybdenum addition is increased to 1%. The molybdenum addition also confers improved creep properties upon the chromium containing alloys.

Nickel additions to chrome alloys greatly enhance the corrosion resistance and the mechanical properties. Coil tubes of 18-8 (approx. 18% chromium, 8% nickel) are unexcelled in resistance to sulfur attack. In low rates of "creep" the 18-8, as Type 304, is only excelled by the special alloys used for gas turbine blading. Above about 1600° F. the 18-8 alloy tends to oxidize readily and the need for a more chromium-rich alloy is indicated.

For tube supports and parts to serve in the firebox of heating coils, a 28% chromium-12% nickel alloy in cast or wrought form is widely used. Type 310 stainless (approximately 25% chromium, 20% nickel) sometimes finds application in fireboxes and the reports from such service are excellent. This alloy can serve for years at a metal temperature of 1800° F.

Where tubes such as used in hydrogen manufacture are to operate at 1800° F., the choice falls on Type 310 (25% chrome-20% nickel) or Inconel (approximately 80% nickel, 13% chromium). A large number of Type 310 alloy tubes formed from strip and welded are in service in hydrogen manufacturing furnaces, also in furnaces cracking oil at very high, 1400-1600° F. temperatures in the manufacture of ethyl alcohol or butadiene and other products.

Extruded seamless tubes of Inconel have been used in hydrogen manufacturing furnaces and in the regenerator service of hypersorber units. The resistance of Inconel to oxidation is considered the equal of Type 310 and its resistance to carburization is considered superior. The mechanical properties as creep strength or stress to rupture strength of Type 310 and Inconel are about equal. The Inconel has a lower coefficient of thermal expansion which is an advantage where thermal stresses are a factor.

Both alloys, Type 310 and Inconel,

*This article was presented as a paper under the title "Use of Certain Alloys to Resist Corrosion in Petroleum Refineries" before the Western Petroleum Refiners Assn., Alma, Mich., Aug. 17, 1951. It is based largely on one given in Calgary, Alberta, Canada, May 23 at a meeting sponsored by the Chemical Institute of Canada.

are quite resistant to the SO_2 contents of normal flue gases. Both will be destroyed if contacted by H_2S when the metal temperature is of the order of 1600° F. to 1800° F. and above. Other things being equal, Type 310 would be preferred where varying sulfur content exists in the gases or product contacting the metal at high temperatures.

Naphthenic Acid Attack: Certain crudes liberate naphthenic acids during distillation. The attack usually takes place in distillation equipment as the naphthenic acids can be cracked to harmless constituents by contacting the feed to other units with a hot product in an accumulator. Naphthenic acid attack is quite pronounced within the temperature range of 400-700° F.

Alloys resistant to naphthenic attack are the molybdenum containing forms of stainless steel, as Type 316 (approximately 18% chrome, 13% nickel, 2-3% molybdenum) or Type 317 (about same as Type 316 except 3-4% molybdenum, Inconel (approximately 80% nickel, 13% chrome). Some heat exchangers of Inconel have been in service exposed to naphthenic acids for more than 8 years and are in good condition. The availability of Inconel in the form of seamless tubes aided in dictating its use.

It is rather remarkable that, while Type 316 or 317 (18-13-3) resists well attack from naphthenic acids, Type 304 (18-8) is destroyed more rapidly than is carbon steel. Both are rapidly destroyed.

While both Monel (2.3 nickel and 1.3 copper) and nickel are resistant to naphthenic acid attack, their susceptibility to attack by sulfur when the metal temperature exceeds 500° F. precludes their use against naphthenic acids unless the materials contacting the metal are truly free of sulfur. Below 500° F. both metals can be used, but Monel is more generally popular in refineries.

Phenol, Furfural, Etc.: The corrosive action of the organic solvents can usually be met by the use of Type 304 (18-8). In some special cases Type 316 or Inconel must be used.

Vanadium Pentoxide: Where the bottoms of certain crudes, as some Venezuelan, are used vanadium salts may attack the metals of coils. The factors essential to attack seem to be:

1. V_2O_5 must be present. This requirement is readily met, for while V_2O_5 readily reduces, it is also readily formed from other oxides of vanadium.

2. The metal must be at a temperature above 1100° F.

3. The hot metal must be in the line of flow of gases through the firebox. As an example, supports of tubes on the side walls may last years. The center supports may last only weeks.

To prohibit attack there must be no metal at 1100° F. and above in line with the flow of furnace gases where vanadium oxides are in the gases. This requires special cooling of center tube supports and assumes the tube temperatures are below 1100° F. Where higher tube temperatures must exist some other fuel must be used.

Apparently, no metal or alloy is immune to attack by the vanadium oxides if the metal temperature exceeds about 1100° F. and the metal surface is open to impingement by the vanadium oxide in its flow through the furnace. The attack appears to be oxidation of the metal by reduction of the vanadium oxide. There appears also to be a slagging or other destruction of the chromium oxide that normally protects the alloy.

Corrosion Below 500° F.

Corrosion occurring in the presence of water assumed to exist in liquid form at temperatures below 500° F. has all the difficult ramifications associated with electrolytic corrosion. In this corrosion a metal is assumed to go into solution at an anode and hydrogen to plate at the cathode. There appear concentration cells, crevice corrosion and other factors to complicate the study.

In general, it can be said that corrosion of refinery equipment at temperatures below about 500° F. is brought about by low concentration of reducing, mineral acids or by weak organic acids. Against these, Monel and nickel are usually adequate, with Monel the more highly favored due to a lower tendency toward pitting in many cases.

Caustic both weak and strong may attack steel and many alloys. Monel is extensively used to resist this attack and has given excellent service where the temperature has been below 500° F. In the case of strong caustic where a temperature higher than 500° F. may be reached, Inconel should be used.

For high concentrations of mineral acids, as hydrochloric or sulfuric, special alloys are used. For instance, Hastelloy B is used to resist hot concentrated HCL, and Hastelloy D to resist hot concentrated sulfuric acid. The Hastelloy B is an alloy containing among other things, 60% nickel and 32% molybdenum. Hastelloy D is an alloy of about 85% nickel and 10% silicon with 3% copper, the remainder iron, manganese, carbon, etc. Hastelloy B is available in wrought form. Hastelloy D is available only as castings.

The three major products of petroleum refineries are: gasoline, lubricants, and fuel oils. The fuel oils have no specific corrosion problems associated with their manufacture. They share often the problems associated with the production of gasoline and the lubricants.

Corrosion in Plant Operations Manufacture of Gasoline

Distillation Equipment: The fractionating columns and bubble towers are most interesting as they often reflect the dual type of corrosion referred to earlier: namely, sulfur attack above 500° F. and liquid corrosion below this level. Where the fuel enters the temperature may be above 500° F. and sulfur attack is to be guarded against. Type 304 stainless steel (18-8) or the stabilized Type 347 (columbium) is widely used as a liner and for caps and trays. Type 321 (titanium containing) must now be considered to replace Type 347.

In the top of such towers, the cold reflux may introduce water which will form an acid if acid gases are present. Hydrochloric acid is often present. In the top of towers experience has indicated that Monel should be applied as linings, caps and trays. The use of Monel should extend downward to a level where a temperature of liquid on the trays reaches 500° F. or higher.

Platforming: Platforming or equivalent use of platinum catalyst to upgrade gasoline is a relatively new process for refining. From published

Meet the Author

B. B. Morton is a native Virginian and attended Virginia Polytechnic Institute, where he received a B. S. in metallurgy. After graduation he worked for the American Smelting and Refining Co. in Mexico, the Bethlehem Steel Co. in Buffalo, and Standard Oil Development Co. in Baton Rouge, La. Since 1935 he has been associated with the International Nickel Co., Inc., and is now in charge of Petroleum Development of its Development and Research Division.

descriptions, some hydrogen attack may be anticipated upon steel parts unless the steel is protected by the presence of carbide formers as molybdenum, chromium, vanadium or others in its composition. Sulfur attack, if it ever becomes a factor, can be guarded against by use of 18-8 stainless steels. These stainless steels are resistant to hydrogen attack.

Isomerization: Isomerization in refineries is carried out in an atmosphere of hydrochloric acid gas. If water or moisture can be scrupulously eliminated from the units, corrosion is practically non-existent. Generally, moisture does enter or is formed in the units and corrosion occurs. Nickel is widely used to line equipment of isomerization units, also as tubing in heating coils. Where vigorous corrosion occurs, Hastelloy B has proven the most resistant of commercially available alloys and has been extensively used.

Alkylation: The high octane aviation gasoline program calls for much alkylate. This is provided from units using HF acid or sulfuric acid as the catalyst. Exhaustive studies have demonstrated Monel to be the most suitable material for use where HF acid contacts metal. Monel also finds use in the units employing sulfuric acid where the concentration is lowered as the result of service. It will be found in pump parts as rods, valves, liners and springs. In valve parts as trim, rods facings, etc.

Polymerization: In the polymerization units, a phosphoric acid catalyst is used. During "blow-back" a corrosive water may condense and attack steel parts and fittings. Monel linings for such parts have been most effective.

The storage of concentrated phosphoric acid presents problems in corrosion. In the absence of oxygen, Monel is the favored material for storing 85% phosphoric acid at temperatures not to exceed 150° F. If halogens are completely absent, Type 316 (18-8-3) stainless may be satisfactory. Where welding is used, the Type 316 should be stabilized with columbium or be of the extra low carbon variety. In the absence of oxygen, Monel would show a penetration rate of about 0.005-0.01 in./year.

At elevated temperatures, concentrated phosphoric acid is very destructive to metals. Linings and packings of carbonaceous materials have been suggested. Hastelloys A and B have been tried with varying results.

Caustic: Caustic soda is widely used in refineries. Monel or nickel are the most satisfactory metals to combat corrosion from this re-agent over the wide range of concentrations encountered in a refinery. Monel lining, heater tubes, grids for rings and other applications represent the use of this alloy.

In mercaptan removal units, sometimes superheated steam is injected. The metal in contact with the steam and caustic may exceed 500° F. For such a location, or other ones where the temperatures may exceed 500° F., Inconel should be used.

Lubricating Oil Manufacture

The methods by which lubricating oils are prepared call for the use of various kinds of solvents.

Organic Solvents: The organic solvents used in the manufacture of lubricants often are quite corrosive on steel. At temperature levels below 500° F. Monel quite adequately resists this corrosion. The 18-8 stainless steels are also quite resistant and are useful for temperature levels above 500° F. as pointed out.

Chlorinated Solvents: Monel or nickel resists the corrosive action of certain of these solvents, notably carbon tetra-chloride. These metals also act to retard the breakdown of the chlorinated solvents to form corrosives. When hydrocarbons are being chlorinated, nickel is the preferred metal with which to build equipment or to face vessels.

Condensing, Collecting Equipment

The shells of condensers are subject to attack from mineral acids that form as the water in the gas stream becomes liquid. Monel lining has been found most satisfactory to resist this attack. The lining can be applied to existing vessels or the vessels can be formed from Monel plate or from Monel clad steel plate. This type of design also applies to accumulators collecting products at temperatures below 500° F. Often only the bottom half of the accumulator vessel is lined as attack is not expected in the upper water-free part.

Condenser tubes are an item of great expense in many refineries. The 70% copper, 30% nickel tubes have done excellent service where corrosive waters or products hasten the destruction of tubes. It is difficult to select a tube suitable to resist a given cause of destruction of Admiralty by speculation; hence, the widespread use of 70/30 tubes in refineries is the result of trial bundles. The behavior of these tubes has often been surprisingly good, and as stated, unpredictable. They resist brackish water, salt water, basic waters, and acid waters well in numerous locations where they occur.

The most useful pumps for handling reflux are of Ni-Resist cast iron (an alloyed cast iron of approximately 15% nickel, 6% copper, 2% chromium—or 22% nickel, 2% chrome), and where centrifugal types are used, the casing and impeller wear rings are Ni-Resist with a Monel shaft.

Where reciprocating pumps are used, the liner, piston and rings are Ni-Resist with valves and rods of Monel. Pumps, as described above, will handle with satisfaction practically any corrosive fluid in a refinery provided the temperature is below 500° F.

Conclusion

An effort has been made to show that the varied corrosion encountered in a petroleum refinery can be largely combatted by the use of a suitable alloy or alloys. It is pointed out that refinery corrosion above about 500° F. is best resisted by the stainless steels or heat resistant types of alloy of the chrome-nickel type; that below 500° F. the electrolytic type of corrosion is best resisted by nonferrous alloys among which, Monel, nickel and 70/30 copper-nickel are outstanding examples.

Bibliography

Additional literature dealing with the combatting of refinery corrosion includes:

1. "Metallurgical Methods for Combatting Corrosion and Abrasion in the Petroleum Industry." Reprint of paper before The British Institute of Petroleum.
2. "Corrosion Tests in Distillation Equipment." Reprint from *The Petroleum Engineer*.
3. "Corrosion in Hydrofluoric Acid Alkylation." Reprint of an article by M. E. Holmberg and F. A. Prange in *Industrial and Engineering Chemistry*.
4. Various Technical Bulletins dealing with the physical and mechanical properties of Nickel, Monel, Inconel, and other high nickel alloys, as well as the resistance of these metals to specific re-agents as sulfuric and hydrochloric acids and caustics.

Copies of the above are available upon request to International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.

How Available Is Nickel?

In the discussion following his paper, Mr. Morton was asked to comment on the availability of nickel over the next couple of years. He did so as follows:

"The answer might be 'how important do you look to Uncle Sam?' Right now nickel is flowing out in terrific streams as far as we normally produced it, but it's out of control as far as our say so goes. I don't think we could produce much more, and it's just simply a matter of how it's going to be distributed. I would say that for the next three or four years it will be a matter for the government to decide.

"Of course, you people are in a mighty fine position. There's no use making jets if you can't fly them. So it will be matter to be worked out and balanced between the number of jet engines to be made and the fuel they'll need.

"As we like to say, there isn't a shortage of nickel, it just isn't adequate to meet the increased demand."

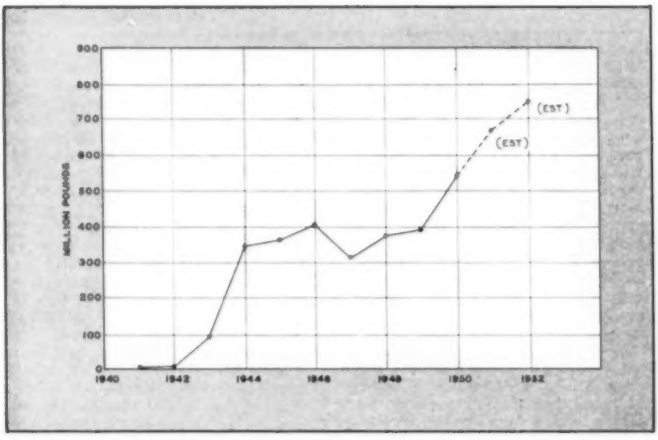

Fig. 11—Styrene Production[1, 11]

Ethylene Petrochemicals

Today and Tomorrow: Optimism and Caution

Following is the second and concluding portion of this paper. The first part appeared in the October issue of PETROLEUM PROCESSING, *pp.* 1101-1111, *inclusive.*

By W. E. KUHN
and J. W. HUTCHESON
The Texas Co., New York

ETHYL BENZENE

Ethyl benzene, made by the reaction of ethylene and benzene, finds its greatest outlet in the preparation of styrene. Styrene is one of the major components of GR-S synthetic rubber and the major component of polystyrene, one of the most popular and widely used plastics. Since 1939 styrene production has climbed from less than a million pounds a year to 539 million in 1950.[1,11] This tremendous growth is illustrated in Fig. 11, and by the data in Table 11.

During the war and in the immediate post-war years the bulk of the styrene produced went into GR-S synthetic rubber. Even though the demand for polystyrene plastics was growing rapidly molders had to be content with what was left from the GR-S program. Later in the post-war period when synthetic rubber production was cut back there still wasn't enough styrene. More users found more uses too fast. In 1949, plastics usage of styrene exceeded that of synthetic rubber for the first time. For a few months molders found supplies fairly plentiful but the international situation again focused attention on a synthetic rubber program and the demand for styrene has been well ahead of supply. In 1950 there was a polystyrene resin production of 261 million pounds and if all copolymer resins and derivatives are included, it amounts to a 355.5 million pound production.[11] The annual consumption of polystyrene[12,13] is shown in Fig. 12. Three major suppliers have embarked on an expansion program of styrene production, and it is estimated that 670 million pounds will be available in 1951 and something over 750 million pounds for 1952. At this rate industry looks to reaching an annual production of one billion pounds by 1955.[11]

It is estimated that 600,000 long tons of GR-S rubber will be required in 1962. Since GR-S contains about 25% styrene, the potential demand for styrene for this end use will be about 335 million pounds.

The growth curve for the consumption of polystyrene in Fig. 12 has been extended, and it is indicated that at least 900 million pounds of styrene will be required annually by the plastics industry by 1962. Plastic molders have estimated that they could have used nearly 400 million pounds in 1950, had it been available.[13]

The total styrene requirement for both outlets in 1962 is, therefore, 1,235 million pounds. In the present

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Technical and Research Div.
The Texas Co.
135 East 42nd St.
New York 17, N. Y.

Table 11—Styrene Production and Ethylene Requirements[1,11]

	Styrene Production (thousand lbs.)	Ethylene Required (thousand lbs.)
1938	203	65
1939	834	267
1940	2,409	772
1941	4,559	1,461
1942	9,675	3,101
1943	97,655	31,309
1944	349,367	111,977
1945	362,160	116,077
1946	405,655	130,018
1947	310,748	99,599
1948	376,862	120,789
1949	390,446	125,143
1950	539,000	172,796
1951 (est.)	670,000	214,744
1952 (est.)	750,000	240,384
1955 (est.)	1,000,000	312,000

commercial process about 640 pounds of ethylene are needed for each ton of styrene. At this rate, about 400 million pounds of ethylene will be required.

It must be pointed out that to produce 1,235 million pounds of styrene, benzene would be required in the amount of 1,070 million pounds or about 150 million gallons (total benzene consumption in 1950 was 187 million gallons). Certainly one of the limiting factors in styrene production has been the supplies of benzene.

Recent announcements indicate that vinyl toluene, made from ethylene and toluene, will prove a suitable replacement for styrene in many applications. Such a compound, from more readily available material, would help eliminate the barriers to certain expansion programs, particularly in the plastics field. The overall ethylene requirements, however, would not be affected.

ETHYL CHLORIDE

Three methods are used commercially for the production of ethyl chloride. The oldest process involves the reaction of ethyl alcohol with hydrogen chloride. This method has been giving way to the reaction of ethylene and hydrogen chloride, which now supplies the major portion of current ethyl chloride production. One new plant is reportedly making ethyl chloride by the controlled chlorination of ethane. Fundamentally, this should be the most economical of the three processes, provided an adequate market can be found for the polychlorinated by-products.

The U. S. Tariff Commission first reported the production figures on ethyl chloride in 1948. In that year 274.6 million pounds were produced, and in 1949 the production rose to 306.5 million pounds. These data, together with annual production estimates[10] back to 1935, are shown in Fig. 13, and also in Table 12. Estimates have been made[11] of the amounts of ethyl chloride produced by the hydrochlorination of ethylene and these data are also included in Fig. 13 and Table 12. From these data it is possible to determine the trend in the consumption of ethylene for ethyl chloride manufacture. This information is presented in Fig. 14 and Table 12.

Although no break-down is available on the amounts of ethyl chloride consumed in its various end uses, it is known that the major outlet is in the manufacture of tetraethyl lead. The manufacture of ethyl cellulose also requires ethyl chloride in considerable quantities. There appears to be no competitive material for ethyl chloride in these two outlets. Ethyl chloride also finds limited use as a refrigerant, an anesthetic, and as a solvent.

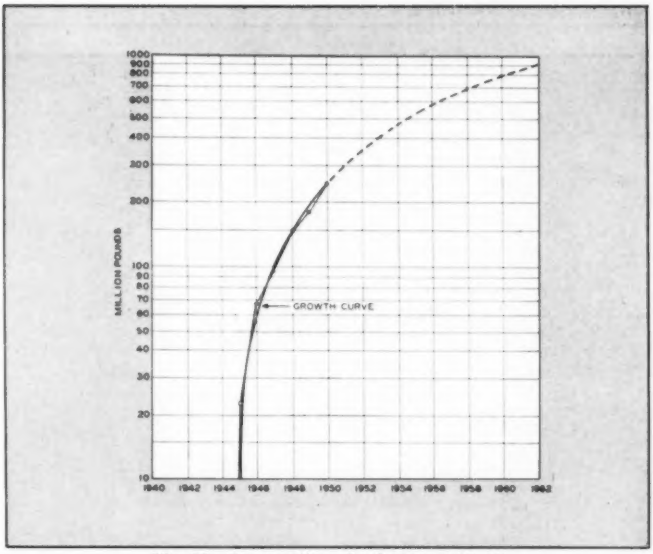

Fig. 12—Consumption of polystyrene[12, 13]

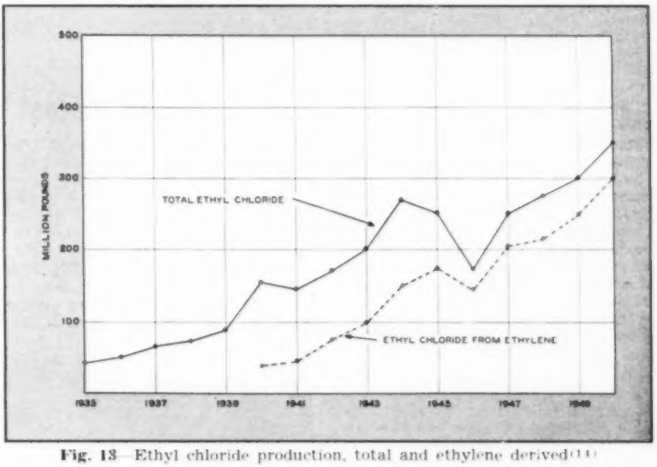

Fig. 13—Ethyl chloride production, total and ethylene derived[14]

Table 12—Ethyl Chloride Production, Total and Ethylene Derived, and Annual Ethylene Requirements[14]

Year	Ethylene Chloride Produced—Total (million lbs.)	Ethylene Chloride Produced—Ethylene-Derived (million lbs.)	Ethylene Requirements (million lbs.)
1935	40	...	...
1936	50	...	...
1937	65	...	...
1938	75	...	...
1939	90	...	...
1940	155	40	18.3
1941	147	45	20.5
1942	170	75	34.2
1943	200	100	45.7
1944	270	150	68.5
1945	250	175	79.9
1946	175	145	66.2
1947	250	205	93.6
1948	275	215	98.2
1949	300	250	114.2
1950	350	300	137.2
1951 (est.)	400	350	159.8
1952 (est.)	500	450	205.5

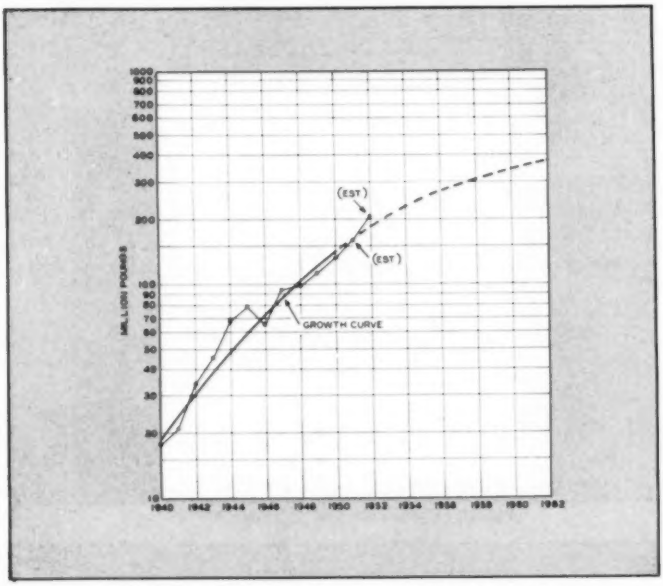

Fig. 14—Consumption of ethylene in ethyl chloride manufacture

Although ethyl cellulose is a relative newcomer to the realm of cellulose derivatives, now dominated by cellulose acetate and cellulose nitrate, the possession of certain desirable characteristics in the plastics and protective coating fields has caused its production to rise from an estimated 5 million pounds in 1943 to over 20 million pounds in 1948. Ethyl cellulose may not continue this rapid rate of growth, but it is believed that it is firmly established and its future growth will make increasing demands for ethyl chloride.

Demands for tetraethyl lead are particularly great in the present state of national emergency. It seems probable that these demands will increase and thus this requirement for ethyl chloride will increase.

The growth in tetraethyl lead plant capacities shown below verifies this statement:

TEL PLANT CAPACITY

	Million Pounds
1952 (est.)	530
1951 (est.)	420
1950	350
1945	296
1944	259
1941-43	221

The growth curve of Fig. 14 on the consumption of ethylene for ethyl chloride manufacture has been extended to 1962, allowing for the production of ethyl chloride by processes not involving ethylene, e.g., the direct chlorination of ethane. The potential demand for ethylene for ethyl chloride in 1962 is estimated at 350 million pounds.

ETHYLENE DICHLORIDE

Ethylene dichloride is usually produced by the vapor or liquid-phase reaction of ethylene and chlorine in the presence of a catalyst. It is also recovered as a by-product in the manufacture of ethylene oxide by the chlorohydrin process.

The U. S. Tariff Commission first reported the production of ethylene dichloride in 1948, when 235.9 million pounds were produced. By 1949 production had risen to 245.9 million pounds. Estimates of the ethylene consumed annually since 1940 in the production of ethylene dichloride[7] have been plotted in Fig. 15 and a growth curve has been arbitrarily drawn to show the trend in ethylene consumption.

Ethylene dichloride is used in the manufacture of Thiokol products, antiknock fluids, vinyl chloride and ethylene diamine, and is used as a solvent and as an insecticide. No end use distribution is available.

For solvent purposes ethylene dichloride meets serious competition from other chlorinated compounds, and in the soil-fumigant field, a mixture of 1,3-dichloropropylene and 1,2-dichloropropane offers ethylene dichloride keen competition.

The use of ethylene dichloride in the manufacture of Thiokol and ethylene diamine has no important competitive materials. Thiokols are made by the reaction of ethylene dichloride and alkali polysulfides. These rubber-like products can be vulcanized and they have unique solvent resistant properties.

Ethylene diamine is made by the reaction of ethylene dichloride and excess ammonia under pressure. Usually more than 5 mols of ammonia per mol of ethylene dichloride are used. If the proportions are lowered the products are the polyethylene polyamines, such as diethylene triamine and triethylene tetramine. Ethylene diamine is used as a solvent for fats, oils and waxes. During the war, ethylene diamine was used as the basis of a new explosive, Halcite, the dinitramine of ethylene urea. The polyethylene diamines are used in soaps and detergents.

Ethylene dichloride readily loses the elements of hydrogen chloride to give vinyl chloride, which is used

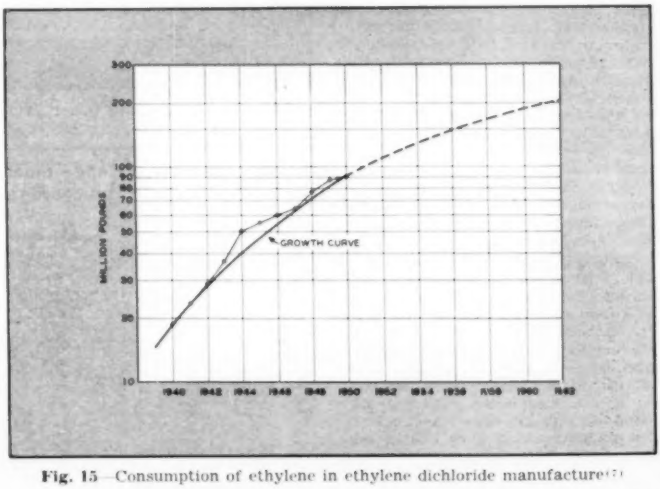

Fig. 15—Consumption of ethylene in ethylene dichloride manufacture[7]

extensively in the rapidly growing plastics field for the preparation of polyvinyl chloride, polyvinyl chloride -polyvinyl acetate and other interpolymers.

The arbitrary growth curve in Fig. 15 shows the consumption of ethylene in the manufacture of ethylene dichloride to be increasing rapidly. Several factors point to continued growth for the next ten years. The use of ethylene dichloride in antiknock fluids will continue to increase, as will the demands for specialty solvents such as ethylene diamines. Should the explosive, Halcite, again be desired in view of the present emergency, demands for the diamine would be of even greater magnitude. The manufacture and use of Thiokol may not see spectacular gains, but the products have become well established and will probably increase some in annual volume as their properties become more familiar.

The greatest opportunity for the growth of the ethylene dichloride market undoubtedly lies in vinyl chloride manufacture. Competition to the use of ethylene dichloride in preparing vinyl chloride is the process involving the addition of hydrogen chloride to acetylene. Again, as in the case of ethylene oxide, the economics of the two processes, particularly in regards to raw material costs, will be the key factor in the future. The growth of the vinyl resins industry has been staggering, with volumes consumed rising from 1.2 million pounds in 1939 to over 325 million pounds in 1950.[11] If vinyl chloride from ethylene dichloride can be made economically attractive, the demands for ethylene in this end-use alone will be greater than the extension to the growth curve in Fig. 15. This curve indicates that 200 million pounds of ethylene will be required for ethylene dichloride manufacture in 1962.

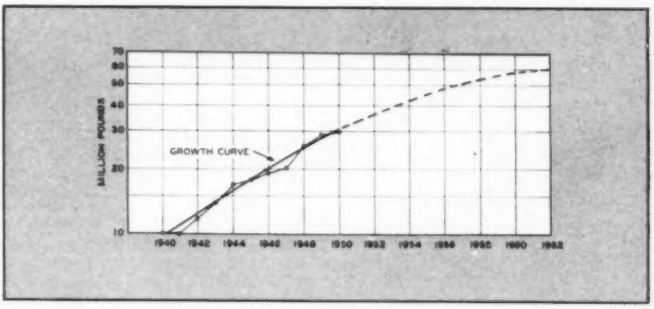

Fig. 16—Consumption of ethylene in ethylene dibromide manufacture[7]

ETHYLENE DIBROMIDE

Ethylene dibromide is prepared by the reaction of ethylene and bromine in the presence of a catalyst.

No specific production figures on ethylene dibromide are available, but an estimate of the ethylene consumed annually[7] has been plotted in Fig. 16. A growth curve has been drawn to show the trend in ethylene consumption.

Assuming a 90 per cent yield on the reaction, the same as it obtained in the preparation of ethylene dichloride, the estimated 30 million pounds of ethylene consumed in 1950 would make about 180 million pounds of ethylene dibromide.

The major outlet for ethylene dibromide is for use in combination with tetraethyl lead in antiknock formulations.

Demands for ethylene dibromide will undoubtedly parallel the growth of tetraethyl lead formulations. As previously mentioned these products are in great demand at the present time and undoubtedly will be for years to come.

The arbitrary growth curve in Fig. 16, on the consumption of ethylene in ethylene dibromide, has been extended and shows that about 50 million pounds of ethylene will be required in 1962 for ethylene dibromide manufacture.

POLYETHYLENE

It is believed by many that polyethylene will soon become the most important plastic in terms of pounds produced. A unique combination of physical properties and low raw material costs would seem to justify this conclusion. Polyethylene is unparalleled in its resistance to low tem-

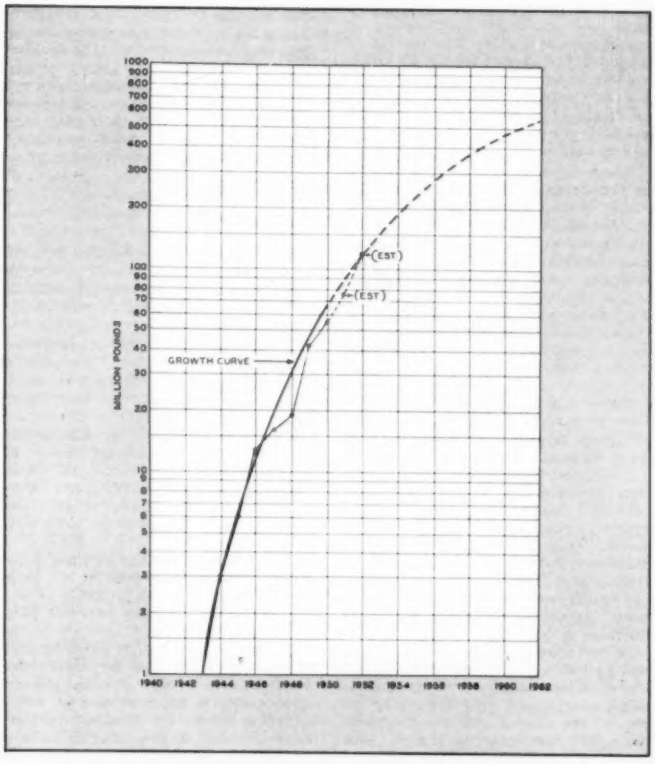

Fig. 17—Consumption of ethylene in polyethylene manufacture

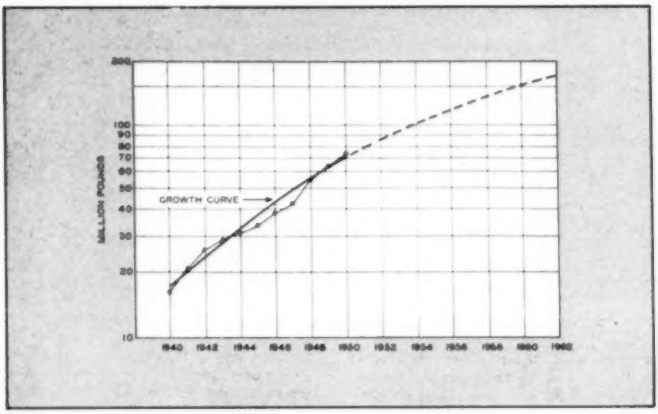

Fig. 18 Consumption of ethylene in miscellaneous chemical manufacture[7]

peratures. Most plastics, even with large amounts of plasticizers, become brittle at low temperatures. Polyethylene requires no plasticizers. It has the lowest specific gravity (0.92) of any plastic, and this is important to an industry in which most uses are based on a volume requirement and the products are usually sold on a cents-per-pound basis. Thus, polyethylene, although costing more per pound than the heavier vinyls, is still more economical to use.[15]

Polyethylene may be produced by either low or high pressure polymerization of ethylene in the presence of a suitable catalyst. Relatively pure ethylene is required. The manufacture of polyethylene began in this country in 1943 and by the end of that year total production was about one million pounds. Expansions have followed and present facilities can produce about 55 million pounds annually. Planned activities will probably more than double this producing capacity by 1952.[16]

Expansion of polyethylene production, although very rapid, has not progressed at a pace equal to the demand for commodities made from it. Too much of the cost of the product is represented by amortization of the extremely expensive equipment required. Therefore, the demand will not be met for some time.

Data on the annual production of polyethylene are not available, but estimates of the amounts of ethylene consumed in its manufacture have been plotted in Fig. 17 and an arbitrary growth curve drawn to show the trend of ethylene consumption.

The unique combination of properties of polyethylene has provided excellent features for its acceptance in the plastic field. It is flexible at low temperatures, has excellent electrical insulating properties, and is chemically resistant to most solvents. Good resistance to water vapor transmission, high tensile strength, and resistance to corrosive media plus the ease of fabrication add to its desirable properties.

The need for material with good electrical insulating properties at both low and high frequencies for radar circuits during World War II provided the first impetus to large-volume production. Until 1948, its use as electrical insulation remained the most important outlet. In 1950, polyethylene sheeting and film took nearly half of the amount produced.

The polyethylene properties make it an important new packaging material. Initial difficulties encountered in the use of this film in automatic packaging machinery have been overcome. Flexibility at low temperature has led to the use of this sheeting in the packaging of frozen foods. For many packaging uses, however, cellophane is much more economical and decorative. Polyethylene will not replace it except where the extra cost is justified.

Paper coated with polyethylene has become a much wanted material for the inner layer of multiwall bags and as a wrapper for various food items. Fabrics can be toughened by coating with polyethylene. Unbreakable polyethylene bottles have become extremely popular in the past few years. Polyethylene dishware manufacturers have sprung up all over the country. New uses are arising constantly and which ones will become large-volume outlets for polyethylene is difficult to judge.

In the next ten years, polyethylene will probably be the most rapid growing chemical based on ethylene as a raw material and may eventually be one of the largest volume chemicals from this raw material source. Acceptance of polyethylene by molders, fabricators and the general public certainly indicates that the future demands will be great. Military demands for polyethylene will continue and additional quantities for the civilian market will be required. It is difficult to judge the volume of the ultimate market. The extension of the growth curve in Fig. 17 of the consumption of ethylene in polyethylene has been drawn endeavoring to compensate for retarded plant expansion due to high investment requirements. Even with such limitations the curve indicates that about 550 million pounds of ethylene will be required annually by 1962.

OTHER USES

Numerous processes use smaller amounts of ethylene in the manufacture of chemicals. Although these uses are widely scattered, it has been estimated that about 73 million pounds of ethylene were consumed in their manufacture in 1950 compared with about 17 million pounds in 1940.[7] The annual estimates available on ethylene consumption for miscellaneous chemicals has been plotted in Fig. 18 and an arbitrary growth curve drawn. From a conservative extension to this growth curve, it is predicted that the consumption of ethylene in miscellaneous chemical uses will be 170 million pounds by 1962. By nature of the scattered uses, the extension does not take into consideration the possibility that some of the materials now being prepared in small quantities may develop into large-volume products by 1962.

SUMMARY

The ethylene consumption in 1950 and the ethylene requirements in 1962 based on the end-use analysis that has been presented is summarized in Table 13.

This tabulation reflects numerous interesting facts. First, however, a comment on the total 1950 ethylene requirement derived from end-use of its derivatives. This consumption value of 1,536 million pounds agrees well with the preliminary report of the U. S. Tariff Commission which has indicated the ethane and ethylene consumption for chemical conversion for the year to be 1,834 million pounds.[1]

The projected values indicate a total of 3,946 million pounds of ethylene will be required in 1962, an increase of 257 per cent over the 1950 consumption.

Except for the use in polyethylene, the end-use distribution of ethylene requirements is not due to change appreciably in the next decade. Polyethylene shows the greatest percentage rise and is predicted to have a ten-fold increase in production. The major portion of the potential re-

quirements of ethylene in 1962 will, of course, be used in ethylene oxide and in synthetic ethyl alcohol production.

This increase in ethylene requirements in the next decade of 257 per cent is believed to be conservative and does not, in most cases, reflect the rapid growth of the past ten years. One reason for this has been mentioned in our discussion; namely, that acetylene will probably be produced commercially and will supplant ethylene as a raw material for some purposes. Allowance has been made for this development. On the other hand, it must be realized that this increase in ethylene requirements has been based solely on commercially available products. It does not take into account the possibility and the probability that many chemicals based on ethylene that are now either in the research or pilot plant stage may make further demands than those accounted for above. Ethylene derived chemicals certainly have not reached a peak production but are still in a field that is increasing substantially and continuously.

CAUTIONS

The petrochemical industry, whether it be the ethylene derived-chemicals part of the industry or the industry in its entirety, by reason of its spectacular progress has a singular allure for the individual, the group, or the already existent company contemplating entry into or expansion of the field. However, there are various caution signs—many of which are obscure—which should be carefully observed. It will be useful and enlightening to examine some of them and to weigh their implications.

The implications apply, of course, in greater or lesser degree according to particular circumstances. But, on the basis of a variety of data presently to be shown, it is clear that enthusiasm must be tempered with caution when the critical decisions are being made which will commit a new entrant in the petrochemical field to initial major investment.

There is no assurance that the enterprise will be profitable: petrochemistry is a young, growing industry full of hazards—it is not a touchstone for profit. The careful, studied approach is especially recommended for the individual or group schooled only in petroleum technology. In the latter field, the traditional thinking is oriented to moving a large volume of products which, by their nature, are quite unlike purified chemicals.

The processing of purified chemicals is governed by severe restrictions—physiological effects, toxicity considerations, safety requirements, international chemistry standards, innumerable legislative controls and so on—and by the demand for an endless variety of grades of products required by the chemical market. Thus, between the petroleum and the chemical industries there is a fundamental difference of thought.

The distinctions are based, logically enough, on the simple realities of raw materials, processing technology, types of products, and methods of marketing.

Investment Requirements

The first caution sign for the newcomer is that of investment requirements. It is true that there would be little difference in investment costs if the chemical plants were as large as our refineries. In major refinery equipment, it is recognized by everyone that with increased size and investment cost per barrel throughput drops significantly. In general an eight-fold increase in size of essential refinery equipment would reduce investment costs per barrel throughput by 3. A review of equipment sizes in petroleum refining and in chemical industries as well as other like comparisons seems to indicate that the average petrochemical installation is about $\frac{1}{8}$ of the size of the average petroleum refining equipment. On this basis, due to size, the comparative investment requirements per barrel in the petrochemical industry are about three times those in the petroleum industry.

The comparison here presented is based both on some recent information compiled, and studies covering each industry in its entirety. A continuing study by Coqueron and Pogue[17] shows the total overall investment per barrel per day in the petroleum industry to be $4,280. In the petrochemical field, a similar study reveals the per barrel per day total overall investment to be approximately $12,500.

Thus, due chiefly to size, which is governed by product demand, one must think in terms of higher investment costs than are typical of modern refinery equipment. There are some additional and higher investment requirements due to the need for special alloy equipment, to the need for special linings in vessels and lines, and to the fact that much of the construction in chemical plants has been inside construction; but these considerations are over-shadowed by the size factor.

Product Costs and Size

A second caution sign for the potential investor is the relationship of the size of a petrochemical plant to the cost of the end product. This is a critical relationship as Eugene Ayres[18] has shown in his report on the costs of ethylene production from four-cent propane. The study is based on 1950 construction costs.

COST OF MANUFACTURE OF ETHYLENE BY CRACKING OF 4c PROPANE

Annual Capacity, Million Pounds	Ethylene, c/lb.
10	6.8
30	4.9
60	4.1

As can be seen, it takes enormous processing capacity to keep the cost of manufacturing ethylene on a level with raw material cost. Thus, the newcomer must reckon his competitive position at least partly in terms of plant size. Those who visualize "vest-pocket" units cannot hope to compete favorably with the larger installations now in operation or projected.

The cost per pound of manufacturing ethylene will, of course, be reflected in the cost of the end petrochemical. Further—and here the significance of plant size compounds itself—end product cost might be magnified additionally by the size of those units in which the ethylene and its subsequent products are processed. The capacity-cost relationship, as shown above, would hold step-by-step through the processing, from propane (in this instance) to the end petrochemical. Size may well mean the difference between profit and loss.

Utility Requirements

A third caution sign for the potential investor to note is that which indicates the utility requirements in petrochemical processing. Again, a comparison with the petroleum industry is relevant. And again, the needs of the petrochemical industry are many-fold greater. Some typical comparisons showing the ratio per

Table 13—Ethylene Consumption: Today and Tomorrow

	1950			1962			
	Commodity Production (Million Pounds)	Ethylene Requirement (Million Pounds)	Per Cent Distribution	Commodity Production (Million Pounds)	Ethylene Requirement (Million Pounds)	Per Cent Distribution	Per Cent Increase
Ethylene Oxide	483	483	31.4	1,116	1,116	28.3	231
Ethyl Alcohol (synthetic)	706.5	495	32.2	1,564	1,110	28.1	224
Ethyl Benzene	539	173	11.3	1,235	400	10.1	231
Ethyl Chloride	350	137	8.9		350	8.9	255
Ethylene Dichloride		90	5.9		200	5.1	222
Ethylene Dibromide		30	2.0		50	1.3	167
Polyethylene	55	55	3.6	550	550	13.9	1,000
Other		73	4.7		170	4.3	233
TOTAL		1,536	100		3,946	100	257

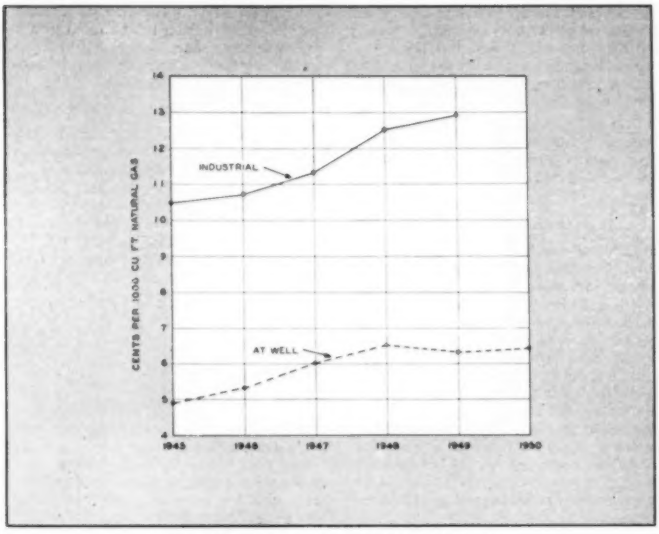

Fig. 19—Average natural gas prices[24]

barrel of charge stock, or feed, follow:

RATIO OF UTILITY REQUIREMENTS

	Refineries		Petrochemical Plants
Fuel	1	to	10 to 20
Steam	1	to	3 to 10
Power	1	to	3 to 10
Water	1	to	10 to 100

It would be well for all concerned to keep in mind the final ratio shown—10 to 100 for water—in view of the worsening state of water supply throughout the country. These utility requirements are again, in part, a reflection of size and further an indication of the extent to which the petroleum refiner practices heat recovery.

Cost of Raw Materials

Another caution sign to be considered with care is the trend in prices for raw materials. As an example the price trend for natural gas, as shown in Fig. 19, is upward.

Other raw materials for petrochemicals have had a history of price fluctuation, but prices now appear to have passed their low mark and are definitely moving upward as demand increases.

Geographic Location

There are, of course, many other important caution signs which should be scrutinized with a high regard for the hazards implied. Some of them can be mentioned briefly. The geographical location of a petrochemical plant is of paramount importance. Not only the price, as mentioned, but also the availability of raw materials must be considered. The shipping terminus for products has an important bearing on chemical costs and selling prices. Further, the over-all problem of transportation bears most importantly on the question of entering the petrochemical field. This factor becomes very significant with the practice of quoting delivered prices on petrochemicals. The combination of these considerations might well dictate the selection of the petrochemical to be manufactured.

Transportation Rates

A comparison of freight rates for ethylene petrochemicals will reveal an average of more than twice those for petroleum products. The spot comparison in Table 14 makes this clearly evident.

The need for thorough study of transportation rates can best be understood by a glance at a population density map, Fig. 20, which reveals the location of the greatest centers of purchasing power. For interest, the present census of petrochemical plants is included on this map. The location of plant and the location of market indicates the magnitude of the transportation problem in the petrochemical industry.

Marketing Considerations

The foregoing remarks certainly indicate that there are some difficult obstacles in the marketing of petrochemicals. None, however, are insurmountable. Earlier, mention was made of the fundamental differences in technological thinking between the petroleum and petrochemical industries. An important difference similarly exists with reference to the distribution and marketing of the products. The distinctions again arise from inherent differences in the products each industry manufactures.

Handling of the various grades of chemicals presents problems quite different from those arising in the handling, say, of motor oils and greases. Cognizance must be taken of the fact that the separation of the pure chemical and purification to the degree required by the customer for his end use often result in greater demands on the manufacturing group in the petrochemical industry than in the petroleum industry. Problems relating to distribution—handling, packaging, and so on—are similarly complicated for the products of petrochemistry.

Research, Technical Requirements

A final caution sign for the potential investor is that referring to research requirements and companion technical service requirements. In the opinion of the writers, no petrochemical company can operate successfully without an able research organization. One critical development can severely handicap a petrochemical company. For example, a common raw material in use today may be displaced tomorrow by an entirely new one. If this new raw material and/or the process for making it comes from one's own research laboratory, all is well and progress is being made. Should it, however, come from the laboratory of a competitor,

Table 14—Rail Freight Rates per Hundredweight of Selected Petroleum Products and Chemicals

	Houston to New York	Houston to Dallas	St. Louis to Chicago	St. Louis to New York
Distance, miles	1780	305	276	1040
Petroleum Products:				
Liquefied Petroleum Gas	$1.39	$0.41	$0.44	$1.11
Gasoline	1.11	0.38	0.31	0.79
Distillate Fuel	.92	0.38	0.24	0.73
Residual Fuel Oil	.92	0.38	0.24	0.73
Arithmetical Ave.	$1.08	$0.39	$0.30	$0.84
Chemicals:				
Ethylene Oxide	$2.87	$0.97	$0.68	$1.41
Triethanolamine	2.44	1.08	0.68	1.38
Ethylene Glycol	1.45	0.61	0.42	1.33
Rayon Fiber or Yarn	2.44	1.08	0.93	2.07
Arithmetical Ave.	$2.30	$0.93	$0.68	$1.55

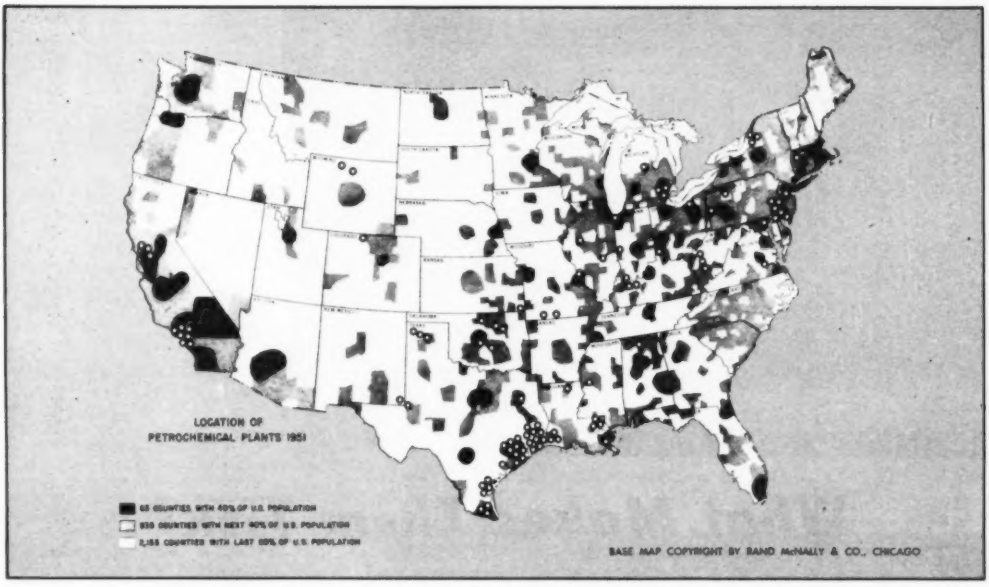
LOCATION OF
PETROCHEMICAL PLANTS 1951
65 COUNTIES WITH 40% OF U.S. POPULATION
939 COUNTIES WITH NEXT 40% OF U.S. POPULATION
2,155 COUNTIES WITH LAST 20% OF U.S. POPULATION
BASE MAP COPYRIGHT BY RAND McNALLY & CO., CHICAGO

Fig. 20—Location of petrochemical plants in 1951 vs. population concentrations

the development may well give him a tremendous advantage and effectively reduce the attractiveness of one's venture into this field.

New petrochemicals can give rise to new chemical industries employing new end uses. Such progress makes new products available in the highly competitive consumer market. Thus, research must be an integrated part of the petrochemical company—an alert laboratory will keep a company abreast of competition and will set the pattern for the company's future. There is ample evidence of the importance of research in both the petroleum and petrochemical industries.

In the petroleum industry the money spent for research is about .85% of total sales. In the chemical, and likewise for the petrochemical industry, research expenditure amounts to about 2.2% of total sales. In actual expenditures for research, the chemical industry almost equals that of the petroleum industry which is now spending in considerable excess of $100,000,000 annually. The necessity for spending large sums on research constitutes another significant caution sign for the petrochemical investor.

Spotlight—Chemical or Petroleum

There is a general opinion voiced that the chemical industry is a most interesting and a most profitable field. Undoubtedly this viewpoint arises because of the rapid growth of the industry, the almost incredible developments resulting from the research efforts therein, and the public demand for these new commodities. There is no doubt of its fascination. The returns, however, are not too far different from the petroleum industry, as is evident by examination of the statistics in Table 15.[19]

Certainly the petrochemical field will grow and petroleum in some of its many forms, will provide more raw materials to the chemical industry than any other source. This overall effort will not have a significant effect on our petroleum reserves or on the major effort of the petroleum companies, namely, to supply fuels and lubricants. Less than 1% of our yearly petroleum production will suffice for today's petrochemicals and will continue to suffice for some time to come.

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Table 15—Net Income and Return for Chemical and Petroleum Companies

No. of Companies	1950 Net Income After Taxes	1950 Book Net Assets	% Return on Net Assets	% Margin on Sales
Chemical Products, 65	$742,513,000	$3,484,916,000	21.3	11.7
Petroleum Products, 45	$1,730,484,000	$11,618,635,000	14.9	10.8

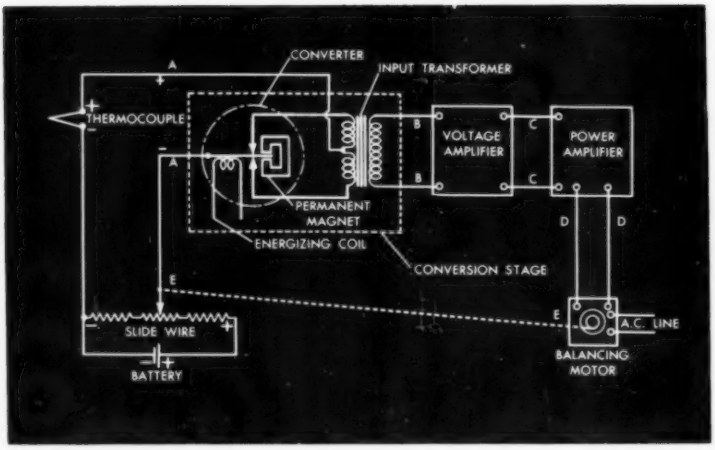


Fig. 38—Typical recording potentiometer circuit

REFINERY INSTRUMENTS

What Makes Them Tick?

Part 5—Temperature Measurement (Recording)

By **CORNELIUS E. SHANNAHAN**, *Instrument Engineer, M. W. Kellogg Co., New York*

IN THE last installment in this series of articles the subject of temperature measurement was discussed. The problem still remains as to how a continuous record of process temperatures is made. As explained thus far, both the potentiometer and the Wheatstone bridge circuits require manual adjustment of a resistance to zero the galvanometer. This function may be adequate in some services but it must be accomplished automatically where temperature recording and controlling are desired, the more widely used type of service in the petroleum processing industry.

This article will limit the scope of the discussion to those instruments which accomplish automatic temperature measurement by electronic means because of their present wider acceptance in the refining industry. It is realized that the so-called "electronic" instruments are electro-mechanical as well as electronic. But as it is commonly interpreted and defined here, it includes those instruments which depend upon electron tubes for their basic operation. There still exists, however, a very great need for those types of pyrometric instruments which are balanced mechanically.

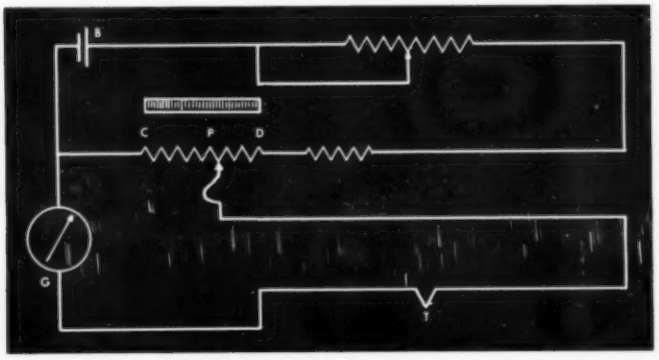


Fig. 39—Typical potentiometer circuit

On the potentiometer circuit, one method to indicate or record automatically temperature is illustrated in Fig. 38. From the thermocouple through the slide wire and up to points *AA*, there has been no change in the circuit shown in Fig. 39 (included as Fig. 35 in Part 4 of this series, October, p. 1121). A voltage will appear across *AA*, the direction of which will depend upon the unbalance between the thermocouple and the slide wire. That is: when the thermocouple voltage is higher than the slide wire contactor, one polarity will appear across *AA*; while if the slide wire contactor voltage is the higher of the two, the reverse polarity will occur. From there, the unbalanced voltage goes through the conversion stage where it is changed from D.C. to A.C. The converter (as circled in Fig. 38) consists of an energizing coil and a permanent magnet. Depending upon the half cycle of the supply voltage to the energizing coil, one of the contacts will be closed during the positive half cycle and the other during the negative half cycle. The converted signal then is multiplied by a "voltage amplifier" from which it passes to a power amplifier and then to the balancing motor.

The balancing motor recognizes the phase of the output from the

power amplifier and accordingly balances the instrument through the mechanical linkage *EE*. The polarity of the signal at *AA* determines the phase of the alternating voltage at *DD* which, as previously explained, determines the direction, in which the motor shall turn. Illustrated in Fig. 40 are two typical potentiometer installations. By following the above description, the complete operation of the instrument may be followed.

Fig. 41 illustrates diagrammatically at *A* a method one instrument manufacturer uses for automatically balancing a modified Wheatstone Bridge system. There are a few differences between the bridge employed in Fig. 41 and the DC bridge discussed previously. Referring to Fig. 41 at *B*, it will be noted that instead of the conventional resistances, there are two capacitors; one fixed and one variable in one of the branches. Use of a variable intermesh condenser eliminates slide wire wear, and permits greater sensitivity than a step-by-step slide wire. Whether the degree of increased sensitivity is of any value would depend upon the process application. It also becomes necessary with condensers to have an AC source in order to establish a flow of current through the complete bridge. The Wheatstone now, instead of having a relationship of resistances, has one of impedances to resistances; that is $Z_1/Z_2 = R_3/R_4$, where Z is equal to impedance.

Basically, the same bridge theory heretofore mentioned applies to this circuit. And as long as the above relationship holds, the bridge is balanced. The reason two condensers are used is to eliminate any unbalance due to slight frequency changes. Since $Z = 1 \div (2\pi fC)$, it becomes clear that only the capacitances are involved for the Z_1/Z_2 relationship. (f = frequency and C = capacitance.)

Now, as the resistance bulb changes resistance due to temperature variation, an unbalanced voltage is set up,

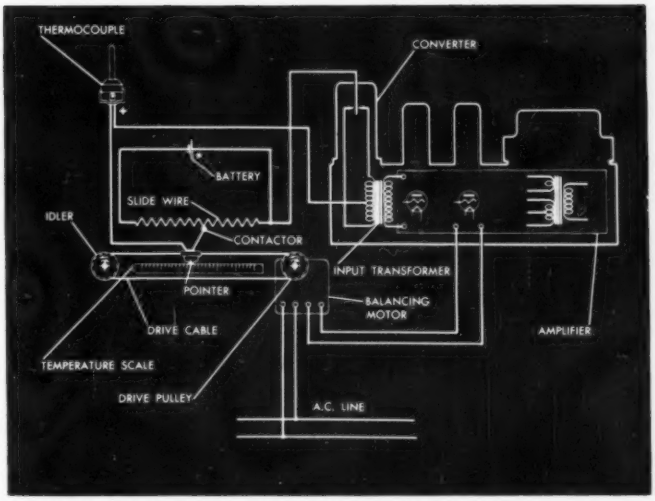
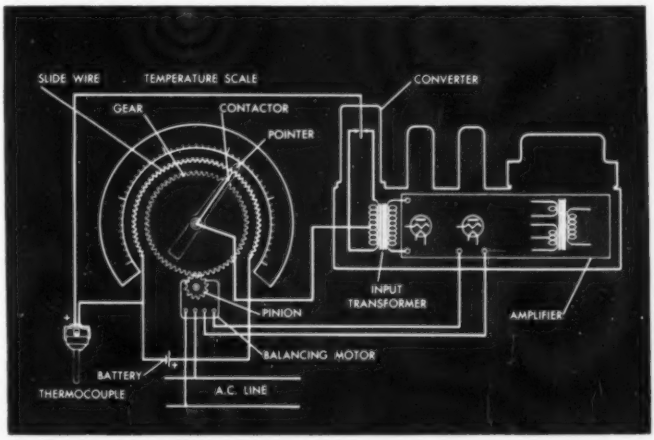


Fig. 40—Two typical installations (above and below) of a recording potentiometer



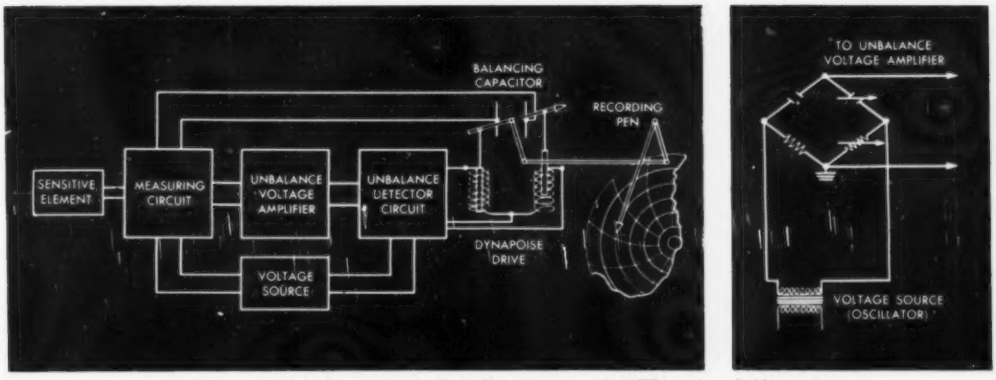


Fig. 41—A method for automatically balancing a modified Wheatstone bridge system

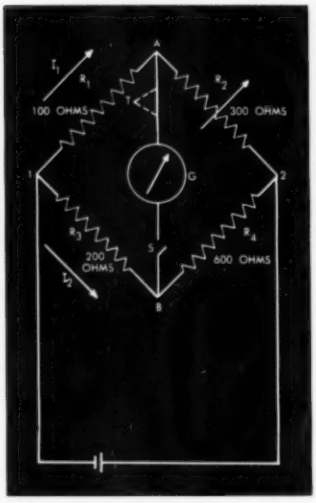


Fig. 42 Wheatstone bridge circuit

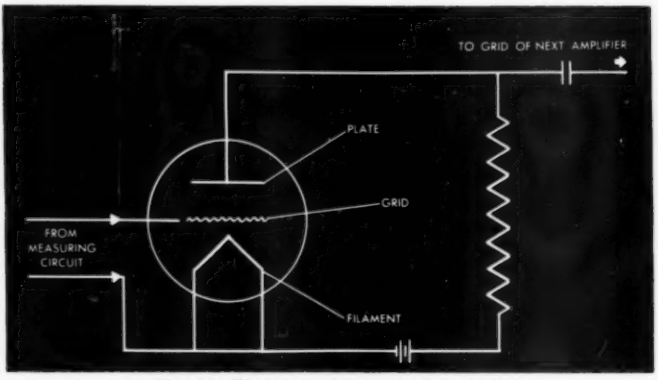


Fig. 43 The triode electronic tube circuit

the phase of which with respect to the source voltage is dependent upon whether the resistance increases or decreases. Referring back to the original discussion of the Wheatstone bridge in an unbalanced condition, see Fig. 42 (included as Fig. 37 in Part 4 of this series, October, p. 1122), it will be noted that with current flowing from point 1 to point 2, the potential at *A* was 75 and at *B* was 80 volts. Following the same mathematical approach, when current alternates from 2 to 1, potential at *A* is 25 and at *B* is 20. The unbalanced voltage as it comes from the measuring circuit is not powerful enough to drive the balancing mechanism, and must therefore be amplified. Since the unbalanced voltage is already AC, the DC-AC converter becomes unnecessary, and is coupled directly to the first stage amplifier.

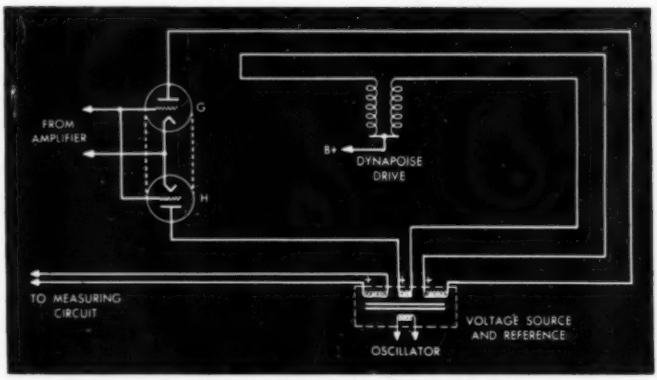


Fig. 44 Conventional phase sensing circuit

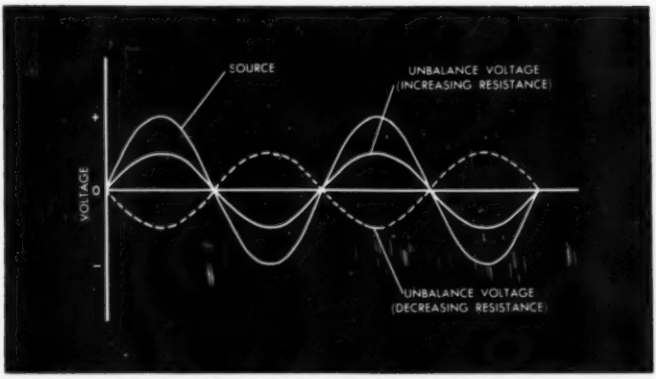


Fig. 45 Phase diagram for a phase sensing circuit

Although the fundamental principles of an amplifier are too well known to require detailed explanation, a brief description will be given to complete the picture of how an electronic instrument performs. The triode, illustrated in Fig. 43, furnishes the means by which a small signal may be amplified many times its original strength and concurrently reproduced in its proper proportion. The unbalanced voltage of the measuring circuit places a charge on the grid of the triode, the polarity of which determines plate current flow. The plate current reproduces the fluctuations being fed into the grid and thus a much stronger current is derived than was put in, while all of the fluctuations are retained in their relative magnitude. In Fig. 43 the plate is connected to a coupling condenser from which it passes through another stage of amplification. Amplifiers of conventional electronic instruments are resistance coupled. A detailed description of these would serve little purpose in these articles.

After the unbalanced voltage of the measuring circuit has been amplified, the next step is to determine the phase or direction of the unbalance. For this purpose, a conventional phase sensing circuit is used, as shown in Fig. 44.

The amplified unbalanced voltage

is impressed upon both grids of a dual triode vacuum tube. The same voltage source that supplies the measuring circuit energizes plates *H* and *L* of the dual triode tube so that when the measuring circuit is positive, plate *H* is positive and plate *G* is negative. If, for example, because of temperature change, the unbalanced voltage is such that it is in phase with the source voltage, as shown in Fig. 45, it will be in phase with plate *H*. Thus when plate *H* is positive, the grid will be positive and will pass more current than plate *L* (which when positive will have a negative grid). Plates *H* and *L* are each connected to solenoid coil and energize these coils accordingly. The variable capacitor is mounted integrally with a cross arm, each end of which is connected to the solenoid core (Fig. 46).

Now, as the unequal currents energize the coils, the balancing capacitor moves in unison with solenoid cores until the measuring circuit is rebalanced and equal and opposite currents are set up in the coils. When the system is balanced, no alternating current is impressed upon the grids. As a result, the two grids produce current through their respective coils equal and opposite, thus equalizing the pull on the cores and holding the balancing capacitor steady.

A schematic diagram of the complete system is shown in Fig. 47. A quick summary of the above operation follows: For an unbalance of the system due to temperature change, an unbalanced voltage is produced in the measuring circuit, the phase of which with respect to the source voltage is determined by the direction in which the resistance changes. The unbalanced voltage, after being amplified, passes to the phase sensing circuit which analyzes the phase of the unbalance and rotates the variable condenser in the bridge to rebalance the system.

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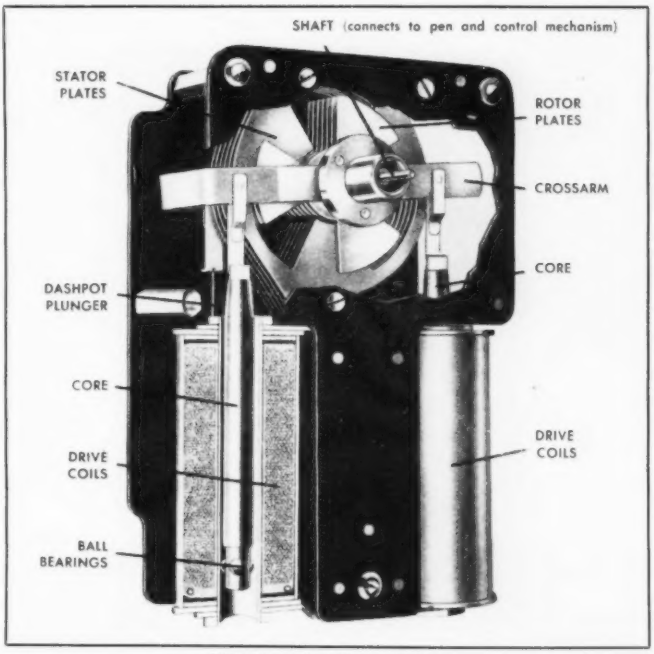


Fig. 46—Balancing capacitor

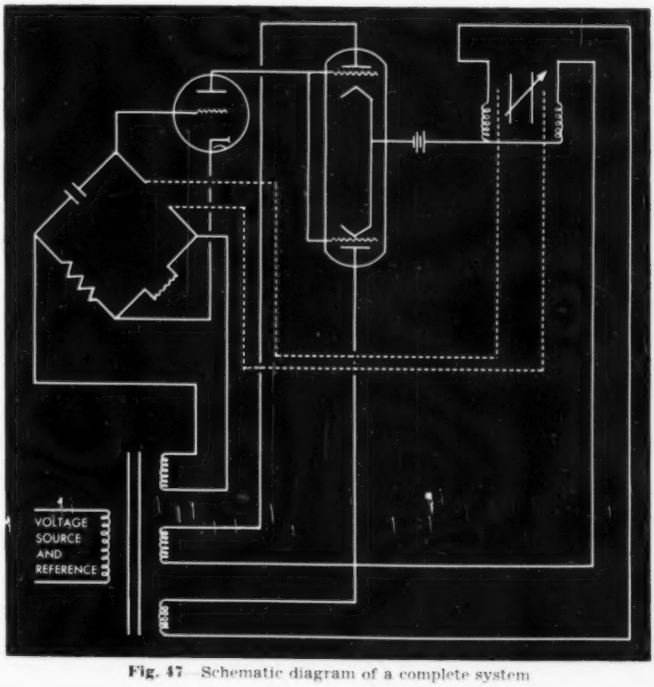
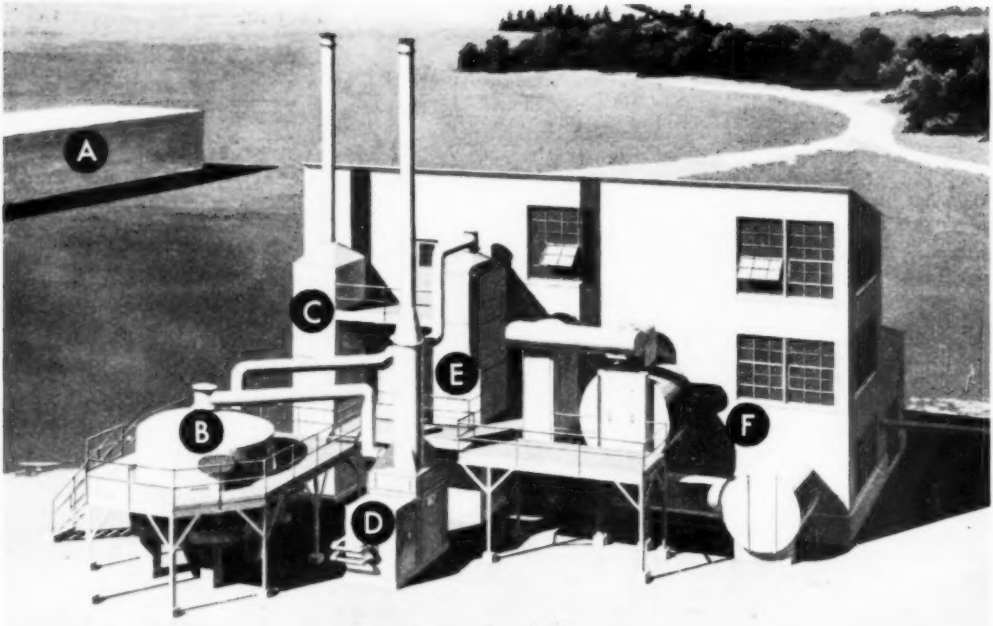


Fig. 47—Schematic diagram of a complete system



SULFUR RECOVERY PLANT designed by Foster Wheeler for Royalite Oil Co. Ltd. in Turner Valley, Alberta, Canada, shown in above artist's conception, is one of latest for making sulfur out of hydrocarbon gases. It will turn out 30 tons per day. Shown are (A) pile of finished sulfur, (B) H_2S-to-sulfur converter, (C) wash tower, (D) furnace, (E) wash tower, and (F) waste heat boiler and economizer

Sulfur-from-Petroleum . . .

700,000 Tons per Year by Mid-1952

A Staff Report

REFINERY and natural gases will soon be the source of nearly 700,000 long tons of sulfur annually —25% more than the petroleum industry is expected to use next year in its own processing operations.

A survey just completed by PETROLEUM PROCESSING shows that 22 plants for the recovery of elemental sulfur from hydrocarbon gases are either operating, under construction, or pretty definitely planned in the U. S. Three plants are in operation on the west coast to convert refinery hydrogen sulfide directly to sulfuric acid.

A summary of the available data concerning these plants is given in the accompanying table. The survey does not cover the sulfur which refiners reclaim or salvage from spent sulfuric acid and acid sludge.

Two plants are also being built in Canada. Shell Oil Co. is putting in a unit at Jumping Pound, Alberta, which is expected to be in operation early next year and will turn out about 27 tons of sulfur per day. Royalite Oil Co. Ltd. is building a 30 ton/day unit at Turner Valley, Alberta, scheduled for operation in April. Both plants will use H_2S from natural gas.

During 1950, according to Freeport Sulfur Co., the petroleum industry consumed a total of 472,000 tons of sulfur—mostly in the form of sulfuric acid. During that year, crude runs to stills were at the rate of about 5,740,000 b/d. Relating sulfur consumption to crude runs, PETROLEUM PROCESSING has estimated that the oil industry should use nearly 530,000 tons of sulfur this year, and 552,000 tons in 1952.

If that forecast is correct, then the 700,000 tons the industry is expected to be producing by mid-1952 will be nearly 150,000 tons more than it actually consumes.

These figures aren't necessarily at variance with those released three months ago by the Petroleum Administration for Defense. At that time, PAD estimated that the industry would need 638,000 tons of sulfur this year to meet its *gross* requirements for sulfuric acid. Some of these requirements are being met by fresh acid refiners themselves make inside their own plants by recovering and reclaiming spent acid—and to that extent the industry's requirements for *new* sulfur are reduced.

Also, the PAD estimate was based on a survey of refiners' sulfuric acid requirements and presumably did not include the relatively smaller amounts of sulfur used by refiners either directly or in the form of other sulfur-containing chemicals and additives.

Of the 22 plants making or planning to make elemental sulfur, eight are now in operation—with a combined annual capacity of over 260,000 tons. Two of these are being expanded and 14 new ones are either under construction or being planned —which will add nearly 345,000 tons to the annual capacity; most or all of these projects are expected to be operating by mid-1952. In addition, the three west coast plants making sulfuric acid directly from refinery gases account for the equivalent of another 90,000 tons of sulfur.

These plants may be only the beginning—but how much more sulfur

Plants for Recovery of Sulfur from Refinery and Natural Gases

Company Name Plant Location	Sulfur Capacity (long tons/day) Operating	 Planned	Source of H_2S Ref. Gas	 Nat. Gas	Remarks[1]
Cities Service Refining Corp. Lake Charles, La.		40	R		Under consideration.
Consolidated Chemical Industries Baton Rouge, La.		50	R		Parsons building; completion expected this month. Will operate on gas from Esso Std. Oil Co. refinery.
Freeport Sulfur Co. Westville, N. J.	40		R		Operating since 1949, using gas from The Texas Co. refinery.
General Chemical Div. (Allied Chemical & Dye Corp.) El Segundo and Richmond, Calif.	160[2]	65[2]	R		Two plants, converting gas from refineries of Union, Wilshire, and California Std. directly to sulfuric acid. Expansion at El Segundo.
Gulf Oil Corp. Pt. Arthur, Texas		60	R		Parsons building; completion expected mid-1952. ($586,390)[3]
Gulf Oil Corp. Waddell, Texas		20		N	Graff has contract; completion expected in Feb., 1952.
Hancock Chemical Co. Long Beach, Calif.	100	50	R		Parsons building 3rd reactor; completion expected in Feb., 1952. ($250,000)
Lion Oil Co. El Dorado, Ark.	10			N	Went on stream last July; built by Graff. ($67,858)
Mathieson Chemical Corp. McKamie, Ark.	100	50		N	In operation since March, 1944. Fluor has contract for expansion. ($198,990)
Mathieson Chemical Corp. Magnolia, Ark.	60			N	In operation since February, 1946.
Phillips Chemical Co. Crane Co., Texas		120		N	Under consideration.
Phillips Chemical Co. Ector Co. (Goldsmith), Texas		145		N	Parsons building; completion expected in mid-1952. ($1,741,000)
Phillips Chemical Co. Eunice, New Mexico		100		N	Out for bids. ($1,498,000)
Rayonier, Inc. Powell Park Co., Wyo.		100		N	Under consideration. ($1,314,000)
Shamrock Oil & Gas Corp. Sunray, Texas	30		R		Went on stream last August; built by Fluor. ($195,500)
Shell Chemical Corp. Houston, Texas		40	R		Parsons building; completion expected by mid-52. ($500,000)
Sid Richardson Carbon Co. Odessa, Texas		20		N	Graff building; completion expected in January, 1952. ($130,830)
Sinclair Refining Co. Marcus Hook, Pa.		20	R		Parsons building. ($320,000)
Standard Oil Co. (Ind.) Whiting, Ind.		55	R		Fluor building; completion expected by mid-1952. ($1,720,000)
Stanolind Oil & Gas Co. Elk Basin field, Wyo.	75			N	In operation since March, 1949.
Stanolind Oil & Gas Co. Sundown, Texas		45		N	Fluor building; completion expected March, 1952.
Stauffer Chemical Co. Torrance, Calif.	30[2]		R		Uses gas from Shell Oil Co. refinery, converting directly to sulfuric acid.
Texas Gulf Sulfur Co. Worland, Wyo.	300			N	In operation since early 1950.
The Texas Co. Pt. Arthur, Texas		25	R		Under consideration.
TOTAL sulfur capacity	905	1055			

(1) Contractors mentioned here are: Ralph M. Parsons Co., Los Angeles; Graff Engineering and Construction Co., Houston; Fluor Corp., Los Angeles.
(2) Sulfur equivalent of sulfuric acid produced.
(3) Figures in parentheses are amounts certified by DPA for accelerated amortization.

can be expected to be recovered is anybody's guess. Most of the large west coast refiners are engaging in recovery operations in one form or another. But only five refineries out of 15 large plants in the Gulf Coast area, one out of four in the Chicago area, two out of six in the Philadelphia area, and none out of three in the New York area are doing anything in the field. In any event, the potential is there.

One engineering firm in the southwest told us they were working on three or four more proposals, one of which was described as "the largest ever considered to date."

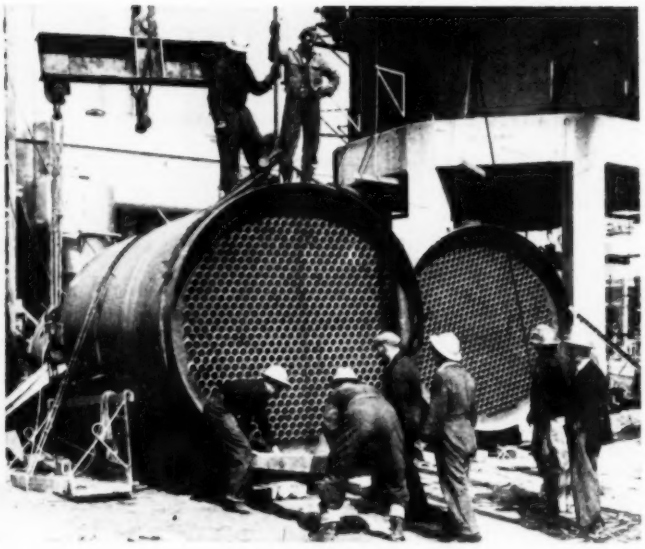
Refiners have a two-fold interest in the recovery of sulfur from their waste gases. Aside from reclaiming a valuable chemical now in short supply, they can in some instances eliminate a common source of atmospheric pollution which is becoming more and more troublesome in some communities.

In fact, the first plant to utilize refinery gases as a source of H_2S for sulfur (the Hancock Chemical Co., at Long Beach, Calif.) was put into operation in 1949 with one of its primary purposes being to reduce the discharge of objectionable chemical fumes.

Economics, however, still pretty much govern the extent to which petroleum operators will become sulfur producers. The principal consideration in any individual case is the amount of H_2S present in the gas supply of the plant—or of several plants where joint recovery installations may be practicable.

At the present time, information available indicates that a plant recovering as little as 15 to 20 tons of sulfur daily can be profitable. According to engineers with the Fluor Corp., the minimum economic size from the standpoint of sulfur alone depends on plant location and resulting freight rate to available customers.

However, in view of today's sulfur shortage and the increasing emphasis on waste disposal, a smaller plant—as low as 5 tons per day—might be justified.



THIS MONTH'S COVER PICTURE shows two waste heat boilers being readied for installation at the new Fawley, England, refinery of Esso Petroleum Co. The two units, each 20 ft. long, operate in parallel on flue gases from a Fluid catalytic cracking unit regenerator. Between them they produce 73,000 lbs. of steam per hour at 135 psi. and 358° F. Temperature of the gases entering the boilers is 1050° F.; they leave at 530° F. Waste heat boilers are economical in catalytic cracking units only if there is a demand for steam at the plant which other sources are inadequate to supply.

Photo courtesy Foster Wheeler Corp.

SAVE THOSE BTU'S WITH

Waste-Heat Boilers

A discussion of the application, selection and economic limitations of these steam generators

By ***PETER W. SHERWOOD***
Chemical Engineer
Pittsburgh, Pa.

INCREASING outlets for byproduct fuel gases and oils of petroleum refineries have resulted in a steady rise in the intrinsic value of these materials at refinery sites during the past few years. As a result, many plants are being forced to review their process operations critically with a view to more efficient utilization of their fuels.

This re-evaluation of optimum processing economy has given large impetus to waste-heat recovery in the form of furnace air preheating in regenerative units and of waste-heat steam generation.

Most established method for recovering some of the heat content of processed stock in the oil industry involves indirect exchange with incoming feed streams. In operations involving high recycle ratios, this method does not satisfy heat removal requirements and supplemental oil cooling must be provided by circulating water or by steam generation.

An increasing number of high-temperature operations results in the formation of large volumes of flue gases which are ejected at a sufficiently high-temperature level to warrant the recovery of a portion of their heat content by steam generation. During years past, the petroleum industry has freely discarded a large share of these potential values—often because book values of available richer fuels were almost negligible. Untold amounts of recoverable energy have thus been dissipated through refinery stacks.

The growing economic justification of steam generation by use of these hot waste gases is a prime factor in changing processing layouts. Application, selection, and economic limitations of steam-generating units in this service define the scope of the present paper.

Major Applications

Primary sources of high-temperature gases are thermal cracking operations. Depending on the process involved, temperatures at the flue exit of the furnace radiant section may vary as high as 13-1400° F. Another potential, though less remunerative, heat source for steam generation is found in flue gases from thermal polymerization, polyforming, and gas reversion processes.

In petrochemical plants, various pyrolysis operations for the production of ethylene, and processes for the manufacture of synthesis gas by methane-steam reforming may similarly be considered suitable sources of high-temperature waste gases which may serve for steam production.

A large source of off-gas heat values are the regenerator flue gases from catalytic cracking operations. These gases are available at 900-1150° F. Exploitation of their sensible heat by steam generation is an important factor in the economics of the process. The regenerator gases are available at a positive pressure which can be readily raised to cover the pressure drop through the boiler installation as well. Special induced draft provisions, which are a major cost item in the vast majority of furnace waste-heat boiler units, are thus avoided.

In oil shale retorting immense fuel values amounting to as much as 50% of the total oil recovery become available in the form of a low-grade (50-

150 BTU/cu. ft.) byproduct gas. Temperature of this flue gas at the retort outlet may vary from 150° F. to 1200° F., depending on the process. High-temperature gases carrying the oil distillate are advantageously cooled by passage through a waste-heat boiler. The fuel value of the residual flue gases must be recovered by steam production. Combustion temperatures with these low-grade gases are low enough to offer the same problems in boiler design as do true waste-heat steam-generating systems. Again the gases enter the waste-heat boiler at positive pressure.

In addition to heat recovery from waste gases, process cooling requirements may justify the installation of a steam-generating unit heated by one of the process gases. These cases do not constitute true waste-heat recovery within the definition of the present paper and they are merely mentioned here for the sake of greater completeness. They include such instances as cooling of vapor phase cracking products, sulfuric acid burner gases, ammonia oxidation products, and quenched gases from hydrocarbon crackers for acetylene production in petrochemical operations. Vast quantities of steam are also obtained as byproduct in gasoline synthesis by the medium-pressure (iron-catalyzed) Fischer-Tropsch process. In the latter case, the steam-generating unit is an essential portion of the reactor cooling equipment and represents a special problem in reactor design.

Some importance also attaches to waste-heat recovery from the exhaust gases of Diesel-type power engines. These installations are particularly notable for the low approach temperatures of the waste gases which may be as low as 600° F., and even 500° F. in isolated cases.

These are probably the most significant applications of waste gas-heated steam-generating units in refinery and petrochemical operations. Additional applications will be found in various more isolated instances. Suitability of waste gases from refinery and petrochemical operations for steam generation must be developed for each case in accordance with the precepts to be discussed below.

Limits of Usefulness

The heat recoverable from flue gases depends on the efficiency of the boiler, on the quantity of the flue gases, and on the gas temperature drop through the boiler.

The theoretical heat recovery, H, can be calculated from the realizable sensible heat:

$$H = We(t_1 - t_2)$$

where:

W = weight of flue gases being handled.

e = mean specific heat between temperatures t_1 and t_2 (weight basis).

t_1 = gas temperature at inlet to waste-heat boiler.

t_2 = gas temperature at boiler outlet.

In practice, this theoretical performance is limited by heat losses from exposed surfaces. Waste-heat boiler efficiency varies between 92 and 96% of theory; i.e., surface losses are relatively smaller than in fuel-fired units because of the lower temperatures involved.

Limit of the lower temperature, t_2, is set by the saturation temperature of the steam being generated and by the chemical characteristics of the flue gas being handled. In order to keep the boiler within economically tolerable size limits, the gas outlet temperature should be at least 100° F. above steam temperature. A further limit may be set by the presence of condensables or corrosive sulfur oxides which will have an adverse effect on maintenance costs unless the temperature is held at 450° F. or higher.

Inlet temperature to the boiler is fixed by the requirements of the process from which the waste heat is rejected. In designing waste-heat boilers for refinery operations it must always be kept in mind that maximum plant production is the prime requirement to which byproduct steam generation must take second place.

Temperature drop through the waste-heat boiler fire side is therefore confined between fairly narrow limits, and efficient operation of the unit depends on maximum exploitation of the recoverable heat. Even a relatively small increase in outlet temperature due to inefficient operating conditions (scale formation, improper draft control) will result in a large loss in steam production. Thus, in a boiler operating with a gas inlet temperature of 1000° F. and an exit of 450° F., an outlet temperature rise of only 25° F. means a steam reduction of nearly 5%.

Principal characteristic influencing waste-heat boiler design are the low inlet temperatures. Whereas fuel-fired boilers depend principally on radiant methods for effective heat transfer, most of the transmission in waste-heat boilers, as determined by the temperature level, is convective. The effect of inlet temperature on predominant mode of heat transfer is strikingly illustrated by the data in Table 1.

Table 1—Effect of Inlet Temperature on Predominant Mode of Heat Transfer in Waste-Heat Boilers[5]

Temperature of incoming gases, °F	2280	1652	752
Heat transferred by radiation, %	70	24.7	3.6
Heat transferred by convection and conduction, %	30	75.3	96.4

Thus, the problems of waste-heat boilers operating with a gas inlet temperature of 2000° F. or higher do not differ substantially from fuel-fired units. In most cases of waste-heat generation in the petroleum industries, the temperature of the available off-gases is well below this level. The lowest temperature at which waste-steam generation is still economically feasible depends on conditions encountered locally. It is, however, usually found that steam generation is feasible if the flue gas temperature exceeds 1000° F. In special cases, such as the exhaust of Diesel engines, waste heat has been recovered to advantage from gases at 600° F.

Boiler Selection

For efficient heat transfer in the convective range, turbulent gas flow, induced by high linear velocities and changing direction, is essential. In water-tube boilers, this is achieved by the use of baffles and close tube spacing, while firetube units are designed with a particularly high tube length-to-diameter ratio. More recently, firetube boilers providing a tortuous path for the gas stream have been introduced. They offer certain advantages in heat-transfer rates without greatly raising pressure drop. Main drawback of such units is the difficulty of tube cleaning.

A ready method of providing waste-steam generation in process furnaces is to substitute water-tubes for all or part of the process pipes in the convective section. In effect, this means that all of the feedstock heating takes place in the radiant section. Advantages are seen for this in the very much greater heat-transfer rates in the radiant-temperature range which would minimize the amount of required process piping (often an expensive alloy steel). In some cases, reductions in alloy steel requirements by this means actually pay for the complete steam boiler installation. Thus, an opportunity is given for boosting the plant throughput per unit furnace investment, without completely wasting the heat still contained in the flue gases leaving the radiant section. To be sure, the fuel consumption per barrel of product will be increased by this process modification. This may be amply repaid, however, by the larger permissible heat input and consequent improvements in plant capacity and by the production of respectable amounts of byproduct steam.

In keeping with traditional petroleum furnace practice, water-tube boilers are widely used for this purpose. A steel coil is provided in the convective section of the furnace through which water is passed by forced circulation at a rate great enough to prevent complete vaporization. An external steam drum is provided for separation of generated

steam from recycle water.

This design, along with other water-tube boilers, is particularly suitable if the gases are still luminous or if considerable additional steam capacity is required through supplementary firing which can be suitably provided in the refractory furnace. It is also definitely advantageous for very high steam pressures (say above 250 psi), which are better contained in the relatively small-diameter water-tubes than in the shell of fire-tube boilers.

On the other hand, definite disadvantages are inherent in water-tube operation. Probably the prime difficulty is the danger of air infiltration through the refractory setting, which is very real in view of the negative gas pressures in most waste-heat boiler systems. Actually, the exact point of air infiltration determines the boiler performance. If air enters within the process furnace (in this case radiant section) proper, a larger volume of gas at design boiler inlet temperature will reach the waste-heat system. In this case, steam generation will be increased, though at the cost of plant throughput. On the other hand, air infiltration into the waste-heat system results in a decrease in recoverable heat. While there will be no change in the total sensible heat content of the flue gases, the system will be diluted and a larger volume of gas will leave at design outlet temperature, carrying with it larger amounts of unrecoverable heat. In addition, the infiltration of air will mean an additional load on the draft fan capacity, which will raise power consumption. In an extreme case, the fan throughput may be strained to its limit and may no longer be able to cope with the design quantity of combustion gases, resulting in a drop in both furnace output and steam production.

The problem of air infiltration is, of course, not encountered in the operation of firetube boilers. This and certain other important advantages tend to favor firetube boilers for most waste-heat installations in petroleum practice. Thus, firetube units are more compact and avoid a brick- or steel-cased fire setting. They are generally cheaper than water-tube boilers, unless intended for high-pressure steam generation. It should be pointed out, however, that steam pressures above 200-250 psi. are quite unusual in waste-heat practice.

Effective heat transfer can be achieved with about equal success in either firetube or water-tube boilers operating in the convective range, provided the unit is properly and expertly designed. In the radiant transfer range, rarely encountered in waste-heat practice, water-tube operation shows certain advantages. Similarly, there is little choice between the fan power requirements of water-tube or firetube boilers. For gas inlet temperatures in excess of 1600° F., a pressure drop of 3-5 in. W. G. is permissible. At lower available flue gas temperatures, the draft drop should normally not exceed 3 in.

Firetube waste-heat boilers are most commonly of the horizontal type. The entire unit with the exception of a small steam space is filled with tubes. The gas duct is arranged so that hot gases do not contact the tube sheet at any point above the water line. The boilers are sometimes set at a slight angle with the horizontal in order to improve circulation. Alternate types provide a separate steam drum at a higher level with a number of riser and downcomer pipes to the boiler unit proper. Horizontal firetube boilers are built with shell diameters up to 11 ft.-6 in. and with tube lengths up to 24 ft.

Certain advantages in duct work and floor space requirements are attained by the use of vertical firetube boilers. For shipping reasons and because of the nature of their steam drum attachments, the shell diameter of such units is in practice limited to 96 in. Gas inlet may be provided at the top or bottom of the boiler. Top inlet is to be preferred whenever there is danger of condensate formation on the gas side, in which case any condensed material will quickly drain.

For convectional heat transfer in firetube boilers, a first approximation to required transfer area may be obtained by the standard equation: $H = UA\,\Delta t_m$. The heat-transfer coefficient, U, is determined by the equation:

$$U = C + D(w/A)$$

in which:

- w = weight of gas flowing, in lbs./hr.
- A = average cross-sectional area of gas passage through the boiler, in sq. ft.
- C = a constant ranging from 1 to 3.5. Its magnitude increases as the tube diameter decreases.
- D = a constant ranging from 0.0005 to 0.004. It becomes larger with increase in tube diameter and in temperature difference between the gas and water.[6]

Draft Requirements

In refinery practice, the waste-heat boiler is an auxiliary unit which must not be allowed to interfere with the satisfactory operation of the process furnace. Since pressure drop through such steam-generating units is quite appreciable, suitable measures must be taken to provide satisfactory draft conditions.

The volume of gases handled by waste-heat boilers is large per unit steam production. In order to maintain the boiler size within reasonable limits and to achieve the turbulence necessary for efficient heat transfer, high linear velocities are required with consequent appreciable pressure drops.

In some small installations working with very high initial temperatures (1500° F. or higher), waste-heat boilers have been reported which operated with high reject gas temperatures and with sufficiently small steam rates to permit the use of natural draft. Such installations are, however, clumsy, inflexible, and of questionable economic value.

The pressure drops encountered in efficient large installations may range as high as 5 in. W. G. No natural draft operating within economic realities of stack size and waste-gas temperatures can overcome such resistance and induced draft must therefore be provided (unless the waste gases are under positive pressure such as the regenerator gases in catalytic cracking).

Induced draft fans thus represent an integral portion of the majority of waste-heat boiler installations and constitute a sizable portion of the cost of erection and operation. Beyond their tangible economic import of making the whole steam-generating unit workable, induced draft fans bring with them additional advantages to the whole furnace operation. For one thing, they may well so improve the fuel efficiency of the operation that the amount of waste heat available to the steam boiler may actually decrease below design expectations. Or, as corollary, it may be possible to increase the rate of combustion and, with it, the process furnace throughput.

Conversely, furnaces which require induced draft anyway derive additional benefits from the use of a waste-heat boiler. Installation of this unit will lower the temperature and thereby decrease the volume of the gases reaching the fan blades.

Use of draft fans is not an unmixed blessing, however. It introduces an element of possible mechanical failure and it requires special precautions to assure that high-temperature gases will not reach the fan blades through some freak failure in the boiler or furnace system. Such considerations also often influence the choice of ultimate discharge from the fan outlet to a central plant chimney rather than through short individual furnace stacks. In case of fan failure it is then possible to bypass the waste-heat boiler and discharge the flue gases by natural draft through a stack which is continuously kept in pre-warmed condition, and no major break in furnace operation need occur.

Preferred fan drive is an electric motor which can operate independently of the steam supply system. In some installations, the use of steam from the waste-heat boiler has, however, been selected, although this

tends to make the system less flexible. Fan power consumption is quite high and increases (per pound of steam generated) as the inlet temperature to the boiler system becomes less (because this requires the handling of larger gas volumes). Steam-driven fans have been reported to consume between 12 and 25% of the waste steam generated.

Control of fan speed should be possible for most efficient utilization at different loads. If a suitable power source is available, the use of D. C. motors is usually preferred for electrically driven units. When local conditions dictate the use of alternating current, small installations may successfully control the draft volumes handled by the control of butterfly valves in the flue. Larger units must, on the other hand, rely on the use of some speed-reducing device such as hydraulic drive, gear reducers, or Reeves drives.

Auxiliary Firing

Once a waste-heat boiler system has been installed, other operations throughout the plant become dependent on this source of steam supply. Occasional downtime of the process furnace may therefore have an adverse effect on the continued operation of other units unless proper measures are taken to assure continued steam production.

Again, it may be realized at the time of the boiler erection that the plant steam demands may periodically exceed the waste-heat supply available to the unit.

In either case, it will be necessary to decide whether continuous satisfactory steam supply is to be assured by the installation of a separate fuel-fired boiler or by augmentation of the waste-heat supply by live fuel.

If the latter course is chosen, the hot gas temperature reaching the boiler tubes must be carefully controlled. Waste-heat boilers are universally designed for lower temperatures than fuel-fired units and the materials of construction are chosen accordingly.

A simple means of providing auxiliary combustion is to inject fuel gas into the waste gas-carrying flue, permitting it to consume excess oxygen which is often present at this point. Here care must be taken that enough primary air is present to allow for ignition (if the gas is below ignition temperature).

Where the furnace is fired with insufficient excess air to satisfy the requirements of auxiliary firing, it is necessary to introduce air into the flue as well. Limitations of this method are glaring and a special combustion chamber must be provided where the amount of auxiliary firing is significant.

To douse the temperatures of augmented waste gases to values which are safe for the boiler, addition of suitable volumes of excess air is sometimes practiced. This control method is particularly wasteful of fuel values, however, and is not recommended except possibly for very small installations, relatively small temperature adjustments, or for emergency service. A more suitable method of control is found in recycling a portion of the reject gases to the boiler inlet.

Operating Routine

Perhaps the most important contribution which can be made by the operators to the efficient working of the waste-heat boiler is to assure cleanliness of all tube surfaces. Even a relatively small deposit will greatly reduce the heat-transfer coefficient of the unit. The resulting higher gas exit temperature means a proportionately much greater loss in steam capacity than would be experienced in fuel-fired boilers.

Clean water side can only be assured by proper water conditioning. For reasons of construction economy and in order to limit the surface area exposed to radiation and convection losses, the modern horizontal firetube boiler employs close tube spacing and restricts shell diameter to a minimum. Mechanical cleaning on the water side is therefore made very difficult and cumbersome. Proper boiler design will, however, provide for ready replaceability of the tubes.

Gas side cleaning is not a major problem with fuels normally employed in petroleum refinery practice. Intermediate cleanings can be performed while the boiler is on stream by means of an air lance which will dislodge soot and dirt from the tube walls and carry them along with the heating gases to the flue. During downtime, a thorough wire brush cleaning should be provided.

The adverse influence of air infiltration on boiler efficiency has been discussed above. In units where air leakage to the gas side is possible, periodic inspection and maintenance of all brick seals of the refractory chamber is an essential part of proper operating technique.

The grave effect of even small heat losses on the steam capacity of waste-heat boilers necessitates the careful insulation of all hot surfaces, including the refractory flues connecting the process furnace and the steam-generating unit. Underground gas-carrying flues have a number of serious drawbacks, not the least of which are the precautions which must be taken against heat losses to ground water.

Economic Suitability

Economic justification of recovering waste heat by steam generation must be determined for each installation on its own merits. Principal factors to be taken into account on the debit side are first investment costs, electric power for fan operation, cleaning, and maintenance costs. On the credit side the fuel savings must be considered, taking its value at the price of the cheapest available fuel which is still satisfactory for boiler firing.

Competitive methods of waste-heat recovery must be considered, above all the use of regenerative air preheaters. Installation of such units may actually be dictated by the thermal requirements of the process furnace. Where this is not the case, however, waste-heat boilers usually have the advantage of greater return per unit investment. Sometimes, it is possible to operate air regenerators in conjunction with or alongside of waste-heat boilers.

The very small heat recovery from low-temperature flue gases generally defeats the usefulness of waste-heat boilers for operations below 800° F. inlet temperature. Lower operating levels may, however, be possible if the waste gases are delivered at positive pressure, obviating the need for induced draft.

Certain imponderables should be taken into account alongside cost comparisons. Most important is the possible favorable effect of induced draft on furnace operation or, where a fan is provided anyway, the reduced power costs derived from lowering the temperature of the reject gases.

The possibility of boosting steam generation above the waste-heat potential by auxiliary firing must also be taken into account in a fair evaluation.

Developments now underway raise the very real possibility that the gas turbine may before long be a formidable—and much more efficient—competitor of waste-heat steam generation. Many difficulties must still be overcome, however, before this unit comes within the realm of economic exploitation in petroleum refinery practice. King and Dent[46] point out that not only will it be necessary to better the design of present-day turbines but that improvements are also needed in the system of collecting the hot gases from various stations and conducting them to a central turbine installation.

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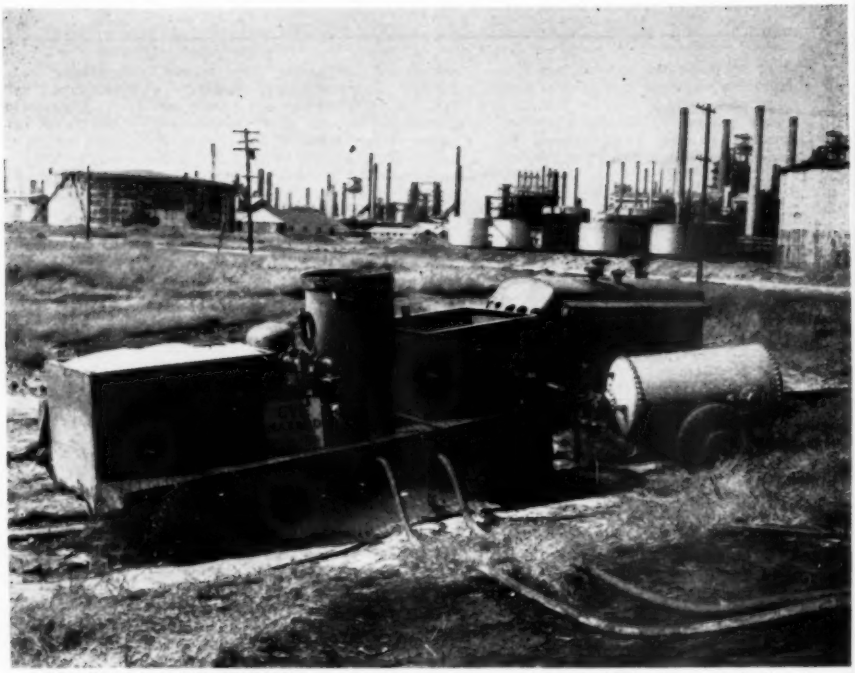


POWERFUL SAND-BLASTER sends sand through two hoses instead of one single line to . .

How to Cut Tank Painting Costs

- Long-distance sandblasting
- Portable paint shops
- Spray only—no brushing
- Strong, alert supervision

By **WILLIAM C. UHL**
Equipment Editor

OUR tank farm painting costs have been reduced from about $22 to less than $10 per square (100 sq. ft.)," Frank Radecke, industrial engineer at Shell Oil Co.'s huge 120,000 b/d Wood River, Ill., refinery told me recently when I asked for some examples of savings in maintenance.

How do they do it? Four important factors contributed to this successful cost reduction program. As outlined by Mr. Radecke, they are:

1. Improved equipment and techniques for sandblasting. This alone accounts for 25% cut in labor costs.

2. Thorough training of the paint crews and strong, alert supervision. An intangible and immeasurable contribution, this is, of course, not a new idea; yet it is of definite importance in the overall picture.

3. Changes in application procedures. By the application of four coats, instead of two, and the use of high quality specially formulated paints, Shell aims for long life and durability in its painted surfaces. Formula paint costs per gallon are approximately equal to those formerly expended for standard proprietary products.

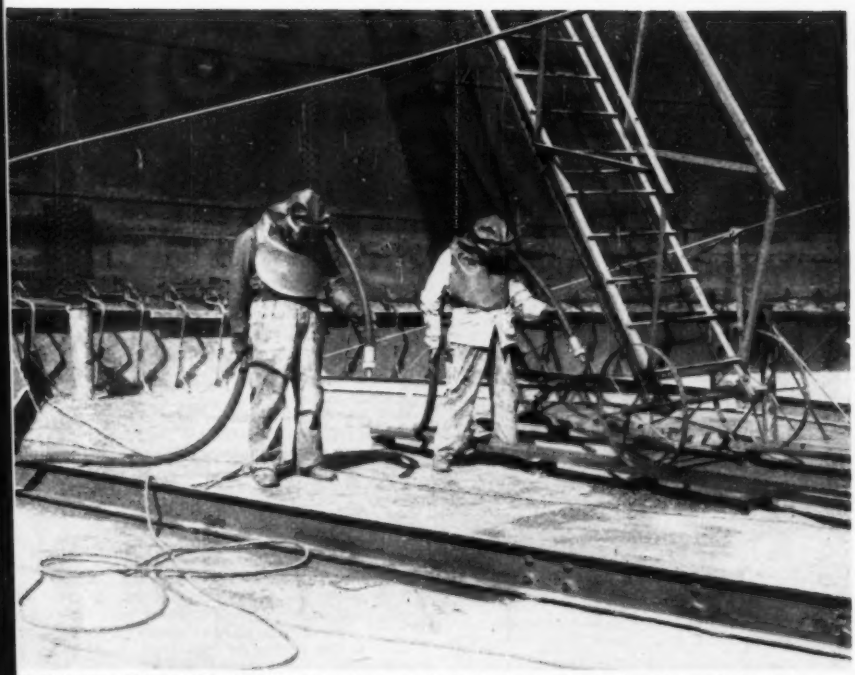
4. Improved equipment and techniques in the actual painting jobs themselves. All paint is sprayed. No brushing is used. A portable headquarters, or "field" paint shop, is set up at each major job. In the trial case history on a small processing unit, actual total cost was 22% under estimates.

Biggest secret to savings is in the change Shell was able to effect in the labor materials cost ratio. Both factors have been rising steadily, of course. The company soon realized the limit of its control over rising materials costs, so it concentrated on labor charges. Today, this ratio of labor to materials is about 1.05/1.00. Before inception of the program, it was closer to 5/1.

It sounded good. How about details? "Well, take the surface preparation or sandblasting phase, where there is an estimated labor savings of some 25%," continued Mr. Radecke.

"On a typical large tank sandblasting job, two sandblasting machines were used formerly. Crews consisted of two men as tenders and two more as blasters to handle the nozzles at the tank itself. The machines were run on 100 psig. air at 250 cfm from gasoline engine-driven, trailer-mounted, typical portable compressors. The machine itself had a conventional, rather small, sand hopper.

"By rearrangement of the piping on the mixing chamber outlet, it was possible to supply sand to two separate nozzles. A Diesel-operated, 500 cfm. compressor that supplies air at 100 psig. was obtained. Approximately 1600 lbs. of sand can be placed in the machine hopper itself and 6,000 lbs. in extra sand is carried in two spare hoppers.



LEANING JOB 175 FT. AWAY, where two men instead of one are blasting the roof of a tank

"With this arrangement it is possible to use one machine and one tender to supply two blasters on the same specific job, which eliminates one tender and one machine. Furthermore, with the added compressor capacity, sandblasting can be done as far away from the machine as 400 ft. instead of 100-150 ft. as with the old equipment. That means the compressor and sandblasting machine can remain stationary during the entire job, and movement is not necessary to reach all parts of the tank."

Is the sand a special type? "Not exactly, although it is different from regular blasting sand and relatively inexpensive", Mr. Radecke explained. "It runs $5.50 to $5.75/ton delivered in carload lots at Wood River, and the consumption is about 2.2 lbs. sq. ft. of new steel tank surface being blasted, so none is saved."

It is called Sawing, or Special Foundry sand. Very uniform and very hard, it tends to peen rather than cut surfaces. The Sawing sand has an AFA (American Foundrymen's Association) grain fineness rating of 30 and the following grain size analysis on U. S. Screens: 30 mesh screen, 10%; 40 mesh 75%; 50 mesh, 13.5%; and 70 mesh, 1.5%.

Improved materials handling is entering into this phase of the cost reduction program. Sand will be delivered to the job site in bags or pallets by Dempster Dumpster, a form of materials-handling truck. This will simplify the job for the tender, who will refill his hoppers by opening and dumping bags rather than shoveling sand in bulk form, as done currently.

Other than re-piping, larger hopper capacity, and using higher pressure air, no further changes were made on the sandblast equipment. The machines are standard commercial models made by Sly Mfg. Co. and Pangborn Mfg. Co.

How did training save? Aren't painters usually skilled craftsmen? Yes, they are usually skilled, but more often with the brush. Shell is using spray techniques almost exclusively. New employes and veterans alike receive a three-session, four-hour, formal training course, emphasizing good technique in spray painting. A portion of the course comprises a training motion picture produced by the DeVilbiss Co., spray equipment manufacturers.

Beyond seeking good craftsmen, the employment procedure aims to obtain men who can be expected to advance. Upgrading is done from within the ranks as much as possible. A condition of employment in the crew is not only the standard painting tests but also intelligence tests. Painters can rise to supervisory level by becoming paint inspectors. This latter position is always filled from the regular crew.

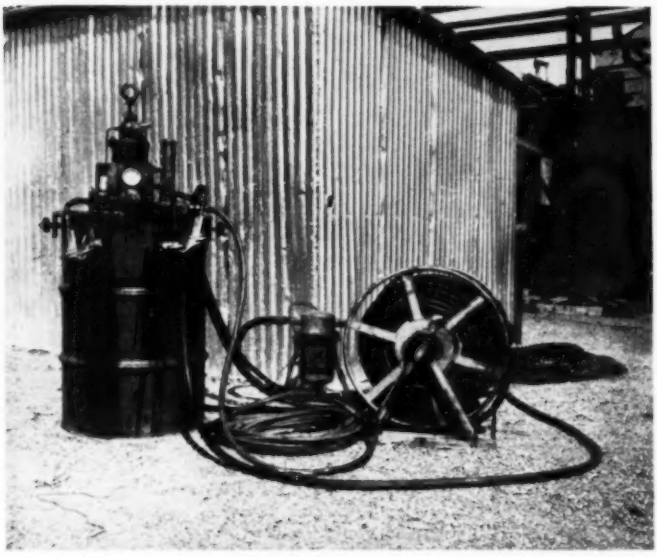
Emphasis in training for high skill in spray painting ties in with the revised procedures for application. These in turn were closely associated with the complete overhaul performed on paint formulations.

Are special paints used? "Yes, paint formulas and specifications are Shell's own," Mr. Radecke said. "They are designed for spray applications as well as durability." It is also held that four coats offer much greater durability and longer life than two coats. In any event, the aim is for a final film thickness of about 6 mils. An example is the following system used for aluminum painting of storage tanks.

The first coat is a primer consisting of an alkyd-linseed oil vehicle with a red lead mixed pigment. It can be sprayed on bare, clean steel, and has excellent flow and wetting properties.

The second coat is also a primer consisting of a red lead mixed pigment in a vehicle of phenolic resin-tung oil varnish. Sprayed also, a primer of this particular formula will flow well only over the other paint coating but not over bare metal unless it is thoroughly sandblasted.

Together, these two primer coats provide the best possible undercoating for the two finish coats; they are inhibitive, compatible to the coating system, and have excellent adhesion. The two finish coats are a phenolic resin-tung oil varnish with an aluminum pigment. A large saving in man-



QUICKLY MOVED AROUND THE REFINERY by truck, this portable paint shop includes a spray pump, large paint drum, and hose reels

hours is realized through the spray technique. In addition, Shell has found the savings in brushes amount to $1,500 yearly.

Where is the paint obtained? Shell buys its paints from the various well-known paint manufacturers, who prepare it to Shell's formulas. All paints are carefully analyzed and inspected in the regular control laboratory at Wood River before being accepted. This work required installing about $500 worth of special paint inspection laboratory apparatus, but the investment has been well worth it. Rigorous maintenance of high material standards has enabled the company to insure good service from the paints used in its maintenance program.

How does this "field" paint shop idea work? "Well, suppose, for example, we have a group of tanks to be painted," Mr. Radecke suggested. "A few empty drums for the pump reservoirs are located at some central point in a knockdown, sheet metal building. Paint is delivered from the central site to spray guns by means of a standard Alemite "Versatal" pump, designed for handling roof coatings and paints. With four guns hooked up by means of Y-connections, it has been possible to spray paint tank walls and roofs as far as 1000 ft. away. In one instance our painters were able to do a job on a 150-ft. high column. As in the case of the sandblaster, this means the field paint shop didn't have to be moved, but stayed at one spot during the entire job."

"Downtime" overnight is no problem. The spray gun pump system is maintained under pressure; the guns are immersed in distillate. Thus, no time is wasted on clean-up. Guns are ready for use the next morning after a few short "blow-outs" to remove remaining solvent.

Fresh supplies of paint are delivered to the drum in the field in 5-gal. containers. The small containers are far easier to handle in the field than 55-gal. drums. Eventually, these field shops will be made portable by utilizing a rubber-tire mounted trailer. Wood River policy is strong for mobility. The maintenance department has several portable tool cribs in trailers. Over 100 motor scooters are assigned to various supervisors and engineers in maintenance and operating departments.

Does the field shop idea really save money? In a recent "trial run", a field shop was set up for a complete spray painting job on a small processing unit. A careful record and analysis of actual costs on the job showed it was accomplished for 22% less than the best preliminary estimates, based on conventional brushing methods used previously on this unit.

Paint jobs on new installations can profit by this technique, too. Current plan is to pre-paint all bare, fabricated piping prior to actual installation instead of afterwards. This can be done in the pipe shop easily enough on all the random lengths. Flanged and welded joints are used primarily. As a result, very little touch-up work is needed after the pre-painting.

How were tank painting costs cut? Based on many years of experience and records, it was found that the average direct labor and materials cost under the old two-coat procedure were in the range of $22 to $25/square, or 22c to 25c/sq. ft. With the new procedures being used in 1950, cost figures were maintained on a number of new tanks totaling 260,000 sq. ft. of surface. The average direct labor and materials cost was $9.20/square (9.2c/sq. ft.) for sandblasting and four coats of paint. A breakdown on this total is shown in Table 1. The small cost differential between first and second (primer) coats is due to a slightly higher material cost on the second coat. The small differential between the two finish coats is due to a slightly higher labor cost on the final coat for touching up, dressing wounds, etc.

Costs on repainting some 180 tanks during 1950 were even lower, according to records Mr. Radecke showed me. Direct labor and material costs in that case, for about 350,000 sq. ft. of surface, averaged $6.20/square. The procedure on the repainting consists of hand cleaning, two coats of spot primer, one intermediate, and one finish coat. However, costs vary widely unit-wise because of the variation in extent of hand cleaning and priming.

How about seasonal fluctuations? Isn't it necessary to lay off painters during non-painting winter months? No, outdoor painting is stopped only during very bad weather, below 35° F. and in rain and snow. Normal winter days in the Mississippi Valley are no obstacle. The year-round base crew is about 20 men. This is raised to about 35-40 during the 8-month full schedule season. Extra jobs, rush operations and the like are handled by contracting outside labor by the job. Labor only is contracted; Shell supplies the materials and equipment.

These are all problems common to any industry where maintenance painting is handled by company employes. Chief savings in labor at Wood River have been by improved techniques, equipment and aggressive supervision.

Table 1 — Average Direct Labor and Materials Cost for Painting 260,000 sq. ft. of Storage Tank Surface

	(Dollars per Square)
1—Sandblasting (commercial)	$2.00
2—First coat of primer	1.80
3—Second coat of primer	1.90
4—First coat of finish paint	1.30
5—Final coat of finish paint	1.40
6—Rigging, hauling, misc. labor charges	0.80
Total	$9.20

No. 5 in a series on How to Order Equipment

How to Get What You Need When You Order Instruments

By D. P. THORNTON, Jr., Southwestern Editor

THE subject of control instruments has become of vast importance to the oil industry in the past decade and, at the same time, there has been an avalanche of changes in the field of instrumentation itself. Today, therefore, the subject is a complex one, making the job of keeping conversant with developments equally complex.

Recognizing the situation, control instrument manufacturers embarked several years ago on an extensive educational program to teach their customers what could be done by instruments and, equally important, how to take care of them. Further, some instrument manufacturers have developed excellent consulting staffs within their organizations which are available for handling unusual and difficult applications.

This educational program has been extended to service matters, also. Several instrument manufacturers maintain regular schools for instrument mechanics; others have service programs where the major maintenance and trouble-shooting jobs are taken off the plant operator's hands by the instrument supplier. By both methods a great deal of educational work is performed on a routine basis.

Nevertheless, difficulties often develop because incomplete information is provided in ordering and requesting quotations from instrument suppliers both for original equipment and repair parts. In some cases, this is due to the adoption by some of the larger companies of "standard specifications," some of which may have failed to keep up with advancing technology.

The matter of the simple Bourdon tube for pressure gages may be cited as an example. Several years ago it was considered very necessary to use drilled bar stock for high-pressure applications and some specifications still require this. However, advances in metallurgy and fabricating techniques now make it possible to use drawn seamless tubing for these services; the resulting tube is said to be much less expensive and equally satisfactory, while some advocates consider them far better than the drilled type for all purposes.

To illustrate incomplete specifications, still using the pressure gage as an example, there is the case of the individual who sent in an order to a gage manufacturer calling for "One pressure gage for a 'Billingsley Machine.'" The manufacturer does not know what a "Billingsley machine" is nor the pressure range, fluid involved or type of gage wanted. At last report, request for adequate data still is unanswered and the order remains unfilled.

Consequently, the first advice instrument manufacturers give their customers to aid in securing the type of instrument needed—be it simple thermometer, pressure gage or the most complex recorder-controller—is: "Tell us what your problem is and what you want an instrument to do?" The best way to do this is with a flow-sheet conference. There is no charge for such a consultation.

Unfortunately some customers seemingly are either convinced they are instrument experts in their own right or afraid they will be sold a "champagne instrument for a beer application." It is becoming much less common in the oil industry to deliberately classify applications as "trade secret", but too many companies still do not take full advantage of consultation services available for the mere asking.

Those who are fearful of being oversold because they do not have expert knowledge may take comfort in the fact that most instrument suppliers do not employ their sales engineers on a direct commission basis. A representative's income not being materially affected whether he sells the "Ex Oil Co." a $40 or $40,000 installation, his primary interest is in doing a competent engineering job rather than "gadgeting up" an application.

Information Is Confidential

There is another point gained by taking the instrument engineer into the buyer's confidence. The buyer may believe he needs one type or size of, say, a tem-

perature controller when, due to the highly specialized knowledge of the instrument engineer, it may be obvious a much more satisfactory job can be done in some other manner. The cost difference usually will be minor when compared with the advantages obtained, and the total may be higher or lower. More than once a customer has been shown that a control instrument, per se, was not even needed.

Traps, for instance, sometimes can be used as level controllers. A pressure pilot can be used to measure the static head of liquid in a vessel and thereby control level. There are several types of flow meters utilizing orifice plates which do not employ the manometer. Some cancel out the square-foot factor and produce linear, direct-reading charts and indications.

Liquid levels in closed vessels may be determined by a capacitance bridge and associated electronic circuits instead of a float, and controlled at one point or two or more electrically or pneumatically. Interfaces between immiscible liquids oftentimes are susceptible to the same treatment. Or, the level may be determined—and controlled—using gamma radiation from radium. Flow, pressure and temperature similarly can be measured and controlled in a variety of ways.

Hence, in one article, it is not practical to attempt a description of every type of control instrument, any more than to try to give details of their application. For these, it is best to consult the instrument manufacturer. In selecting him, consider, first, his reputation for integrity, the buyer's best protection. Second, ask if he will be able to furnish the application engineering (consultation) which may be necessary from time to time. Last, but by no means least, find out what service (maintenance as well as application engineering) he can furnish in the field.

The way this works and the possible ramifications are well illustrated by the recent experience of a large instrument manufacturer:

Company A decided to install a new process, with which it was not commercially familiar, in order to diversify its line of products. There were several unusual control applications in the question-mark state and a number of other instrumentizing problems which would bear discussion. The engineering contractor was not able to solve these questions with his own staff, either. Selection of an instrument supplier was made jointly by the two parties and the engineering company put its problems on the supplier's conference table.

The plant now is being built but is not yet in operation. There has been much consultation back and forth between the engineering contractor and the instrument company. Keeping an eye on budgets, in numerous cases instruments are being supplied which may, or may not, be the final answer as they are presently equipped. But, since the instrument company will have representatives present on start-up (at no charge), some of these questions likely will be resolved on the spot. In other cases, additional control features may have to be installed in existing instruments as experience dictates.

The point is, however, that the plant was not "gadgeted up" from the start. Additional equipment can be incorporated into existing instrumentation readily—when, as and if necessary. But the need will have to be proved to the satisfaction of all three parties involved before it goes in.

One of the worst headaches with which instrument engineers have to contend is not deliberate intent on the part of the buyer to withhold data but usually (1) ignorance that certain data are necessary, (2) an inability to supply it, or (3) simple oversight. Fortunately, except in special or unusual applications, the information required is not particularly complex or difficult to secure.

The same style of listing information required for ordering various types of instruments has been followed as in the preceding articles of this series. At first glance the lists may appear formidably detailed. All the information is not required for *every* order, but certainly on unusual applications, or where the buyer is not sure, all known data called for should be furnished. It should be borne in mind that the listings necessarily are intended to cover instruments available from the principal manufacturers—not just one—and all types of refinery and natural gasoline plant operation.

With ordinary care, the listings should prevent oversights and therefore will minimize, if not eliminate, delays occasioned from frequent call-backs or referrals to secure needed data. They also may prevent situations where the wrong instrument or component is furnished through misunderstandings, ambiguities or typographical errors.

After the lists have been used a few times, experience will decide which items of data may be eliminated safely in any individual case.

Data required when ordering flow control instruments

In general, aside from positive displacement mechanisms, which will be discussed later, there are four general techniques used in flow-measurement: The orifice, venturi, pitot-tube and variable-area float. In all but the latter the instruments operate by measuring the differential pressure created across the element inserted in the flowing stream, using bellows, manometers, diaphragms and modified Bourdon tubes.

The problem with the differential pressure types then becomes a matter of obtaining sufficient differential pressure to accurately measure the lowest flow anticipated and at the same time accommodating the differential created by the maximum flow expected. Another important consideration is to avoid excessive power loss resulting from the irrecoverable pressure drop occasioned as the fluid passes through the measuring element.

Still another, with both controllers and indicators, is to follow changes quickly and accurately, avoiding transmission lags and adequately getting around the difficulties resulting from pulsation.

The venturi has the least net pressure drop but it is relatively large, inflexible and not generally susceptible to adjustment in the field to different applications. The pitot tube develops very low differential pressures and is unsatisfactory for low velocities; it cannot be accommodated in small pipes—generally below 4 in. It is at times used in combination with a venturi in large pipes carrying vapors; the arrangement is called a pitot venturi and is inserted in the pipe as if it were a pitot tube. The venturi is not usually practical here because of its size and cost.

DIFFERENTIAL PRESSURE METERS

For the normal refinery and natural gasoline plant flow measurement, the orifice is most generally used. The trouble-spot from the instrument manufacturer's standpoint, regardless of what means is used to measure the differential pressure created across the orifice by the flowing fluid is the d/D ratio. (d/D is the ratio of the orifice diameter to the inside pipe diameter and may be expressed either as a decimal or percent.)

If the d/D ratio is too high, the incremental differential pressure at various flow-rates will be much lower and measurement less accurate than if the ratio is nearer to zero. However, if a very low d/D ratio is involved, the pressure differential may be so high that the usual instrument will be unable to accommodate it with the conventional 100 in. to 200 in. manometer or equivalent. In consequence, instrument men suggest that selection of pipe size in the vicinity of the meter run preferably

be left to the manufacturer; alternatively, he will select the orifice bore. If, however, the buyer wishes to supply the orifice, he should keep the d/D ratio no higher than about 50% for $1\frac{1}{2}$ to $2\frac{1}{2}$ in. OD pipe; below $1\frac{1}{2}$ in., data are not well established. It is best to go as low as possible while still assuring an accurate measurement without, of course, incurring excessive penalty from permanent pressure drop.

Another common failing when specifying flow instruments is not including sufficient information about flanges. Remember that there are three types of pipe flanges and nine pressure ratings for each type.

The following information is required in ordering differential pressure meters:

1. Application. (Give name of process and what item of equipment. For example, debutanizer reflux, absorber dry gas, steam to reboiler, crude charge.)

2. Type. (Manufacturer's catalog or figure number. If unavailable, or choice to be left to manufacturer, state whether instrument is to indicate, record and or control.)

3. Nature of flowing fluid:
   a. Name and physical state. (Butane, gasoline, lube oil, caustic, sulphuric acid, etc.; liquid or gas.)
   b. Specific gravity (or density), preferably at normal flowing conditions. (State conditions of measurement, especially temperature and pressure if a vapor.)
   c. Viscosity. (May be omitted for gases, water, gasoline and lighter fluids and common chemicals where identified and strength of solution stated.)
   d. Presence of solids or scale-forming tendencies. (Necessary to decide on purging and sealing requirements.)
   e. Corrosive nature. (Very important where fluid is unnamed or uncommon. Required to determine necessity of seal pots, manometer liquids, etc.)

4. Flowing temperature. (Best to also state emergency conditions.)

5. Pressure:
   a. Working and maximum. (Give "normal" also for gases.)
   b. Maximum permissible pressure drop at maximum flow. (Only if known and or critical.)

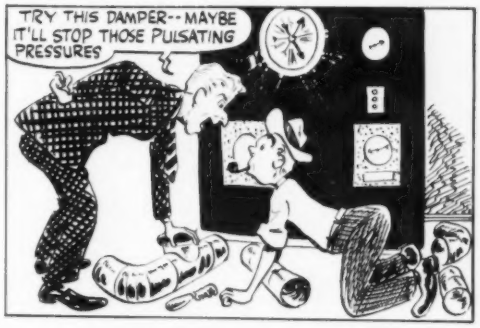
6. Flow conditions:
   a. Rate—maximum, minimum, "normal."
   b. Pipe size and schedule rating.
   c. Temperature and pressure base. (Required for calibration.)

7. Flow measurement:
   a. Specify measuring element if other than orifice or manufacturer's standard. (Venturi, pitot, etc.) (State whether to be furnished by customer or manufacturer.)
   b. Type of orifice connections. (Flange, vena contracta or pipe. Also state pressure rating and type of flange.)
   c. Orifice specifications. (If manufacturer supplies, omit. Orifice diameter, thickness and material may be determined by customer or left to manufacturer. Be sure pipe size is stated. If other than orifice give required specifications or leave to manufacturer.)

8. Instrument: (Recorders and controllers.)
   a. Mounting. (Per manufacturer's specifications; make choice on alternate construction. Usually includes case details, finish, whether yoke or flush, door locks, inside or outside location, etc.)
   b. Range—if known. (Inches of water differential.)
   c. Integrator and whether or not compensated.
   d. Pens. (Number required. Specify type when choice is given.)
   e. Charts. (Order by number. State range and factor if known.)
   f. Chart drive. (Spring or electric 110 v. 60 c.p.s.; 24-hour, 7-day or special requirements.)
   g. Meter chambers. (When applicable. State material of construction—steel, cast iron, etc.—if have option; consider corrosive requirements and presence of solids. Advise rated and maximum pressures, keeping in mind emergency conditions.)
   h. Pressure element. (For example: steel, bronze or other; Bourdon, helical, spiral; diaphragm; bellows; mercury manometer, etc. This generally is based on corrosive nature of measured fluid and type of measuring element standard with manufacturer.)
   i. Accessories. (Usually includes ink, instrument lubricants, mounting yokes, manometer liquids, piping set, straightening vanes, and other items as set forth in catalog.)
   j. Code requirements for electrical circuits. (When applicable.)

9. Controllers:
   a. Location—at measurement point or remote. (If remote and transmission is pneumatic, state distance between transmitter and receiver-controller.)
   b. Controller type: Single, duplex, dual, ratio, schedule, etc. (Exact nomenclature differs with manufacturer. Generally implies, respectively, single controlled element and controller; single controlled element and two control units; two unrelated controlled elements and respective control units. NOTE: Where more than one fluid is involved, data required in Items 3 through 7, above, *must* be given for each.)
   c. Control action. (Proportional, rate and or automatic reset.)
   d. Control setting. (Specify manual or manual-automatic, etc., per catalog options.)
   f. Supply air pressure.

10. Control valve specifications. (If manufacturer to supply. For details of information required, see Article 2 of this series under "instrument operated valves," or manufacturer's catalog. If buyer supplies, advise if valve is: (1) Direct or reverse acting and (2) action on air failure.)



VARIABLE-AREA METERS (FLOW OR VISCOSITY)

The variable-area type flow meter (or "rotameter") differs principally from the types previously discussed in the basis for measurement. An orifice, venturi or pitot tube is not inserted in the line to create a differential pressure for measurement and consequently the instrument reading is direct without involving the determination of square roots to ascertain flow rate.

The basic device consists of a float in a tapered tube, through which the full fluid stream flows at all times; the velocity of the flow buoys up the float. Float dimensions and materials are determined by specific gravity and viscosity of the fluid as well as flow velocities.

These instruments can be used to measure either flow

or viscosity, depending on the characteristics of the float. They can be made to indicate, record, record-integrate and control, with direct or remote reading, in various combinations. Control and recording signals may be transmitted either pneumatically or electrically. Likewise, they may be used as ratio controllers in proportioning and blending, handling one or more "captive" fluid streams. Some designs will handle pulps and slurries and can be constructed for measuring highly corrosive materials.

A modification of the basic instrument intended for flow measurement in larger diameter pipes utilizes two orifices in parallel; one in the main line, the other in the body of the instrument. The bore of the instrument orifice is so sized that the flow rate through it for a given maximum pressure drop across the main-line orifice (corresponding to flow rate) is directly proportional to the flow through the line to be determined.

Linearity of measurement is possible because the two orifices in parallel effectively cancel the square-root relationship observed when differential pressure across an orifice is utilized as a means of measuring flow. The flow through the instrument then is measured by the usual area meter and indicated, recorded or used for control purposes as desired.

It should be noted that the pressure drop across the main line or instrument orifices is not measured. However, advantage is taken of the pressure drop created by the main-line orifice in order to return the shunted fluid to the main stream. There are several different types of instruments based on this system.

When measuring viscosity, the flowing temperature must be known and, in order to eliminate velocity effects from the measurement, the flow must be relatively constant. The latter may be controlled by incorporating a flow-measuring plug in the viscosity instrument along with means (manual or automatic) to control it, or some arrangement like a positive displacement pump to provide constant, known flow.

The following information is required when ordering rotameters for flow or viscosity measurement:

1. Instrument:
   a. Application. (Flow, viscosity, ratio, program, etc.) (It is recommended that application be described in detail, leaving most of the detailed specifications to manufacturer's discretion, preferably including a sketch. Some applications require special piping arrangements; others are unaffected.)
   b. Type of instrument. (Indicator, recorder, controller. May be stated by catalog figure number and manufacturer's nomenclature. Otherwise, tell what the instrument is expected to do.)
   c. Construction material, fittings, float and packing. (Bear in mind corrosive nature of fluid handled.)
   d. Connections:
      1) Direction inlet and outlet connections are to face.
      2) Preference—screwed or flanged.
      3) Pipe size and schedule.
   e. Recorders and controllers:
      1) Mounting—panel or field.
      2) Transmission. (Close coupled, remote; magnetic, pneumatic, electrical.)
      3) Chart drive:
         a) Desired time for one revolution, hours.
         b) Spring wound or electric clock.
         c) Chart graduations. (Direct reading, percent maximum flow or viscosity range.)
      4) Integrator. (Usually optional, specify.)
      5) Electric power characteristics (see catalog for requirements. Be sure to specify any applicable code requirements for instrument, also signal transmissions if pertinent.)
      6) Air supply:
         a) Pressure and quantity available.
         b) Distance between point of measurement and recorder location.
      7) Accessories. (Includes charts, ink, filters, external air pressure regulators, etc.; see catalog.)
2. Fluid handled:
   a. Name and whether gas, liquid, slurry or pulp under process conditions.
   b. State whether transparent, translucent or opaque; nature of impurities (solids, fibers, etc.).
   c. Specific gravity or density at standard (specify) and "normal operating" conditions.
   d. Viscosity. (At operating conditions if known, otherwise at two specified temperatures; any units but preferably absolute.)
   e. Viscosity range. (Omit unless viscosity is being measured.)
   f. Corrosive properties. (Suggest resistant materials if known.)
   g. Steam only. State:
      1) Specific volume at operating conditions.
      2) Quality or degree of superheat.
3. Flow:
   a. Range. (State) "normal", also giving maximum and minimum flow rates. Manufacturer will attempt to size instrument so "normal range" will be at or near 65-75% of full-scale.)
   b. Calibration units. (E.g., percent of full flow with conversion factor, cfm., gpm., lbs./unit time, etc. Percent calibration recommended when instrument may later be used for other services to avoid changing float or tube, charts, etc.)
   c. Characteristics. (Specify steady or pulsating.)
4. Temperature:
   a. Normal operating range.
   b. Maximum and minimum. (This is particularly vital when viscosity enters into design calculations for flow measurement to decide possible viscosity fluctuations and whether they may be safely ignored. Also may bear on instrument construction.)
5. Pressure:
   a. Maximum, minimum and "normal." (Vital for vapors or gases, especially when very low or with small flows.)
   b. Allowable pressure drop across instrument or orifice. (Usually 10 to 20 in. H_2O is maximum needed for accurate measurement with standard instruments.)
6. Control valve:
   a. If buyer to supply control valve state:

Reprints Available on Valve Articles

Reprints have been prepared for the first four articles in this series on "How to Order Equipment"—July, pp. 722-24; August, pp. 844-47; September, pp. 971-77; October, pp. 1128-32. They cover the subjects of valves, both manually operated and non-manually-operated, pumps and heat exchangers. Single copies may be obtained without charge by writing:

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Canada's First and Canada's Largest Cat Crackers... for Imperial!

Imperial Oil Limited placed its first order for process equipment with Kellogg back in 1938. This initial order was for a combination topping and thermal cracking unit. In succeeding years, Kellogg engineered delayed coking, thermal reforming and alkylation units followed.

In 1948 Imperial put Canada's first Fluid catalytic cracker on stream at Montreal...a unit engineered and constructed by Kellogg. In June of this year, another Fluid unit was completed by Canadian Kellogg at Imperial's Winnipeg refinery.

Today, Canada's largest catalytic cracking unit—a 25,000 BPD Fluid unit—is going up at Sarnia, Ontario. Canadian Kellogg is engineering and constructing this cracker as well as a new two-stage distillation unit with a capacity of 50,000 BPD... also Canada's largest.

THE M. W. KELLOGG COMPANY

A SUBSIDIARY OF PULLMAN INCORPORATED

for fifty years an integral part of processing history

NEW YORK JERSEY CITY LOS ANGELES TULSA HOUSTON TORONTO LONDON PARIS

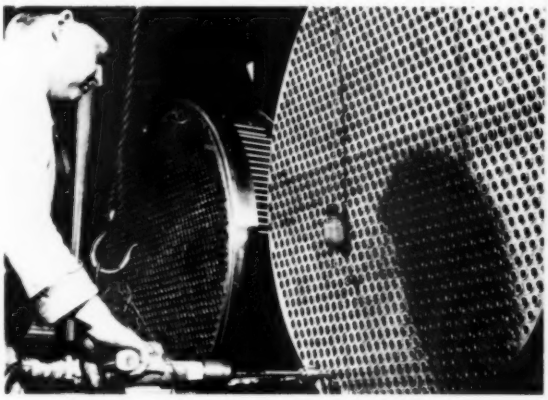
Portrait at

This year is Kellogg's fiftieth of service to industry. At this time naturally, as a group of men—known collectively to the modern business world as The M. W. Kellogg Company—we can think back nostalgically. We can remember the chimney stacks

"Construction's battle with time!"

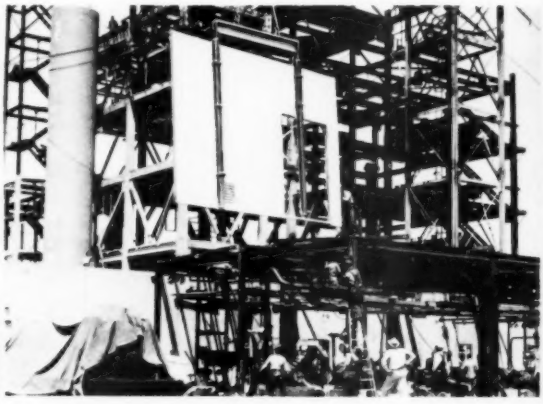
In previous issues of this magazine, "camera portraits" of M. W. Kellogg today have highlighted major aspects of Kellogg's research, development, engineering, procurement and fabricating activities.

This month, the camera picks up the tour on the floor of the Heat Exchanger Shops in Jersey City. From there it swings to the construction lot, focussing on some of the techniques Kellogg utilizes in its continuing "battle with time."



1. *HEAT EXCHANGER FABRICATION*, in essence a combination of piping and vessel fabrication, is another major activity in the shops. Here in the assembly section of the Exchanger Shops, the most modern type of electronic-control roll-in equipment is used. Kellogg heat exchangers in service run the gamut of size — from 6 inch outside diameters to 13 foot diameter shells containing 8,000 tubes.

4. *NOW TAKEN FOR GRANTED* in major plant construction, the towering guy derrick was first introduced in the field by Kellogg construction engineers. The cumulative industry-wide savings—both in time and money—resulting from this one construction innovation are illustrative of the results achieved by constant efforts to improve methods and equipment.

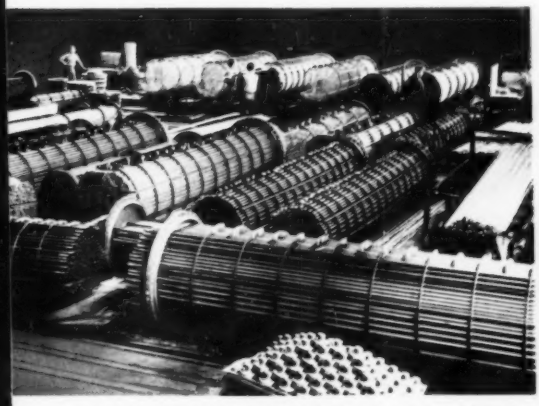


5. *PERMANENCY OF THE KEY STAFF* which plans and directs construction activities — and close day-to-day integration with the design engineering staff are responsible for the company's improved methods in the field. The adoption of the "pre fab" assembly line on the refinery site (that's a whole pre-fab wall in the air) is one of the unusual techniques pioneered by Kellogg construction crews.

Fifty... no. 10

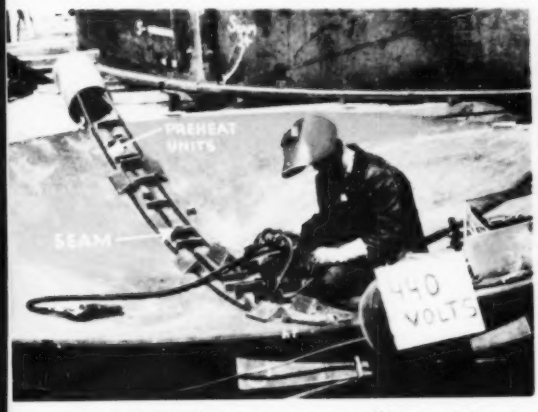
KELLOGG
1901 1951
50th Anniversary

we built in 1901 . . . the first crude vessels for oil refiners in the 'teens . . . our first combination unit . . . the forty-odd Fluid cat crackers built in these years. But, after all, The M. W. Kellogg Company is only a factor as it is able to serve industry today. For that reason, we are presenting this series of monthly camera studies which document our belief that a truly integrated organization can better serve industry to achieve greater earning power. This is No.10 in the series.

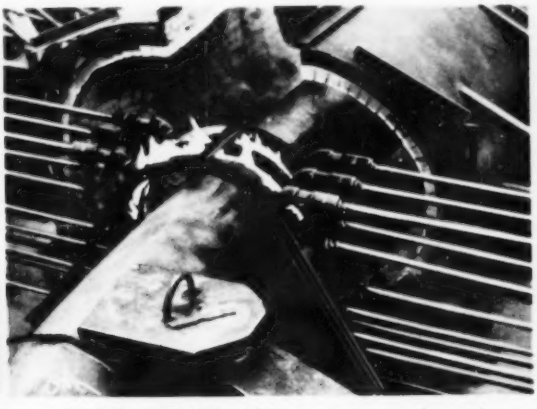


2. *TYPICAL OF THE ASSORTMENT* of exchangers that might be found on the Shop floor on any given day . . . these units represent applications varying from pressures of 5,000 pounds per square inch at temperatures of 1100°F to high vacuum service at below freezing temperatures of the order of liquid oxygen. Final destination . . . a job site.

3. *ON THE JOB SITE* the same principles employed in engineering and fabrication . . . detailed planning, efficient tools (created if necessary), constantly modernized techniques, experienced supervision . . . all pay off in reduced costs and shortened construction periods. The company's permanent construction staff is large . . . can handle as many as forty major construction projects at one time.



6. *ANOTHER RESULT* of close integration in the Kellogg organization is that the precise quality methods used in plant practice are quickly adopted for field use. This is true particularly of welding practices such as induction pre heating shown here . . . which are continually improved as more and more is learned about the behavior of metals.



7. *IN SOME INSTANCES* in field construction, it pays to do most of the pipe bending in the field, and Kellogg's job site pipe bending set ups are virtual miniatures of the company's extensive shop operation . . . from equipment to methods. Piping up to 36 inch diameter has been successfully and economically bent in the field.

NEXT MONTH

. . . in the eleventh and final edition of this series of "camera studies" of M. W. Kellogg today . . . the camera finishes its tour of the construction lot and focusses on the overall picture of Kellogg's service to industry.

Bent to beat stress corrosion!

To master temperature, pressure and chemicals use

M. W. KELLOGG

process equipment

In high temperature operation, stress corrosion has been found to be particularly aggravated adjacent to latitudinal weld seams in segmented pipe bends. Kellogg's exclusive method of incrementally bending pipe up to 96" in diameter provides bends that have no latitudinal welds in the arc . . . that present an even contour throughout their length.

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Special Studies of unusual problems such as stress corrosion and graphitization to assure long life and low maintenance.

Exclusive Equipment for accurately analyzing stresses in piping and providing unique data for critical installations.

Top Welding Performance in shops and in the field by welders accustomed to working under X-ray checks.

Metallurgical Research by recognized specialists who have made major contributions in this field.

Complete Facilities for the fabrication of steel products from simple forgings to specially cast bimetallic devices.

Rigid Quality Control devised by specialists, including chemical and micro analyses as well as mechanical and non-destructive testing.

NEWS FOR OPERATORS IN WESTERN CANADA!

Canadian Kellogg Company has established complete shop facilities for the fabrication of all types of piping at EDMONTON in Alberta Province. Inquire directly or through any Kellogg office.

The M. W. Kellogg Company *(A Subsidiary of Pullman Incorporated)* **New York, Jersey City, Los Angeles, Tulsa, Houston, Toronto, London, Paris**

1) Reverse or direct acting.
2) Air failure to open or close valve.
3) Pressure required to stroke valve under operating conditions.

b. If instrument manufacturer to supply valve give information listed in Article 2 of this series (August 1951, p. 845-6) under "instrument-operated valves" or manufacturer's catalog.

7. Ratio and program controllers.
a. Ratio program controllers: All information listed under Items 2 through 5 must be supplied for all fluids, plus data in Sub-items 1-C, 1-D and Item 6 for all "captive" fluids.
b. Program controllers are special cases and should best be taken up direct with manufacturer's application engineers.

Data required when ordering temperature control instruments

Temperature measurement is not as complicated in many respects as flow determination, and in general oil industry practice there are only three methods in common use: the thermocouple, the resistance bulb and the expansion and contraction of a fluid. All have their inherent advantages and disadvantages. The instruments themselves, especially those based on the coefficient of expansion of a fluid, are quite similar in the methods used for measurement with instruments determining pressure.

More trouble is occasioned in control than in measurement; i.e., the best location for temperature measurement to reduce lag between detection and correction, and the type of control action required to offset lag, maintain temperature at the "set point" and reduce or eliminate overshooting following load changes and start-ups. The literature is replete with scholarly discussions of this subject.

Again, the best bet for the process engineer with a tough temperature measurement or control problem is the consultation service of his favorite instrument manufacturer. There is no point in equipping a process with automatic reset, for instance, if it is not needed, or the various types of proportional and rate-action responses unless they will improve control. Also, there are many instances where recorder-controllers are installed and the records rarely examined subsequently. Unless there is some good reason to have a recorder available, money can be saved by using an indicating controller; it will do everything a recorder can as far as process control is concerned. Perhaps one multipurpose recorder, suitably manifolded, will pay dividends when "lining out" or trouble-shooting, using indicating controllers for normal operation.

It is well also to avoid ambiguities in preparing orders. A manufacturer recently received an order which, among other things, called for four temperature recorders of a certain type, giving catalog model number, range and other details. He appended a statement asking for "six thermal systems for above instrument" which confused the manufacturer completely as to whether he wanted six extra or only two extra thermal systems (the other four being in the instruments ordered). After considerable telephoning it turned out that two extras were wanted for replacement purposes. But how simple it would have been to have said "supp'y two extra thermal systems for above instrument:" then there could have been no reasonable doubts over the meaning.

Information required for ordering temperature instruments:

1. Application. (Debutanizer overhead vapor, still bottoms, reboiler, fired heater, cooling water to exchanger, etc.

2. Type of instrument and quantity required. (Catalog number or model; if unknown, state whether to indicate, record, control or combination; one or more fluids.)

3. Nature of fluid(s):
a. Name (Butane, gasoline, tube skin temperature, furnace gases, etc.)
b. Temperature:
1) Range, °F. or °C.
2) Maximum and minimum. (Principally for overrange protection in case of emergencies or to guide in selecting range.)
3) Normal operating temperature or throttling range. (Usually should occupy approximately center third of scale for multipoint instruments; mid-scale for single point.)
4) Corrosion. (Suggest resistant materials for bulb if known.)
c. Pressure. (Maximum preferred.)

4. Thermal System. (Specify following unless limited by catalog):
a. Thermocouples. (Materials, if known, or if choice available.)
b. Expansion bulb:
1) Actuating fluid. (State preference when optional of liquid or gas filled, vapor pressure types, for temperature range selected.)
2) Bulb elevation vertically above or below instrument case. (To permit compensation for hydrostatic effects.)
3) Location. (Distance between measuring element and instrument; also necessary where pneumatic transmission of measurement is used.)
4) Length of bulb. (Specify where choice is given in catalog; also dimensions and extension lengths where necessary for mechanical reasons.)
c. Resistance element. (Used only with resistance-type temperature instruments where change of electrical resistance is used to determine temperature. Select range desired.)
d. Temperature:
1) Ambient at instrument case. (Control room, etc. Not advisable to estimate. For thermocouples this bears on cold junction temperature.)
2) Ambient for tubing. (Usually outdoor temperature range, obtainable from local weather bureau, corrected as needed for location in plant.)
e. Thermowells or bushing: (Specify appropriate items, depending on installation and catalog options.)
1) Screwed (specify thread), union flanged, welded.
2) Material, thickness, inside diameter and length. (I.D. and length usually set by bulb selected under Item 4-b.)
3) Installation. (Pipe—give diameter—furnace, vessel, etc.)

5. Instrument:
a. Mounting. (Panel, wall, table, portable, etc.)
b. If recorder, specify pens, multicolored dots or numerals, etc., and chart drive speed per catalog options.)
c. Charts, if recorder. (Order by number; see catalog for options.)
d. Case connections. (Bottom, back, etc.)
e. Case dimensions. (Where optional.)
f. If transmitter (whether or not indicating), specify:
1) Supply air pressure.

2) Distance in feet, transmitter to receiver.
3) If electrical transmission, applicable code requirements.

g. If controller, specify:
1) Control action. (Proportional, rate, and/or automatic reset per catalog options.)
2) Control setting. (Manual, manua.-automatic, etc.)
3) Supply air pressure. (For pneumatic control action only.)
4) Valve action. (Direct or reverse. Action on air failure.)
5) Power rating required for electrical contacts. (Only if electric control used. Give code requirements.)
6) If more than one fluid is to be controlled, give particulars for each.

h. Power supply. (If unstated, 110 v. 60 c.p.s. assumed.)

6. Valve Specifications (Same as for flow, q.v.)

Data required when ordering pressure control instruments

Essentially there is little difference between an instrument to measure pressure, and recording or controlling as may be desired, and one which measures temperature by pressure of an expanding fluid. Again, the element may depend on the manometer, diaphragm, spiral, bellows, or modifications of the Bourdon tube. Ionization, hot-wire and McLeod type instruments, as well as their variants, which normally are not found in refinery or natural-gasoline plant process work, are not considered.

Likewise not considered in this installment of the Equipment Series are pressure-regulating and pressure-reducing valves, relief valves and the like, wherein the measuring element is a part of the valve. These were treated in Article 2 of this series—automatically-actuated valves.

The following information is required for ordering pressure control instruments:

1. Application. (Process and item of equipment.)

2. Type. (Manufacturer's catalog or figure number. State whether to indicate, record, control.)

3. Nature of fluid(s):
a. Name.
b. Presence of solids, liquid entrainment, scale forming tendencies, etc.
c. Corrosive nature. (State corrosion-resistant materials if known; liquids also if seal pots must be used.)
d. Temperature. (Maximum and operating; minimum also if unusually cold—advisable to consult manufacturer for recommendations.)

4. Measuring element: (For each fluid involved.)
a. Pressure:
1) Range and "normal" operating pressure.
2) Maximum. (To provide over-range protection, safety protection, etc.)
3) Steady or pulsating.
b. Type of element. (Helical, spiral, Bourdon-tube, diaphragm, bellows, etc. Most manufacturers make several types.)
c. Pressure base. (Required for calibrating certain types of instruments.)
d. Material. (When optional; e.g. steel, copper, bronze, etc.)

5. Instrument. (Indicators, recorders and controllers.)
a. Mounting and case details, bottom or side connections, etc.
b. Pens. (Number; specify type if choice available.)
c. Charts and chart drive.
d. Accessories.
e. Distance from measuring element to instrument if pneumatic transmission used.

6. Controllers.
a. Located at measurement point or remote. (State distance between controller and valve if pneumatic transmission used.)
b. Control action. (For each fluid involved specify proportional, reset, rate, etc., or combinations desired.)
c. Control setting. (Manual, manual-automatic.)
d. Supply air pressure.
e. Power rating for electrical contacts. (Only if electric control used.)

7. Control valve specifications. (Same as for flow, q.v.)

It will be noted that one type of pressure measuring mechanism has not been included in the above discussion, the so-called "volumetric" or "liquid-filled" system wherein a Bourdon tube or modification is connected to a capillary and corrugated metal diaphragm and the system completely filled with a liquid, the nature of which is decided by the application. The fluid pressure (the device is not recommended for vacuum service) is sensed by the diaphragm, which attempts to compress the liquid and thereby moves the Bourdon spring, bellows, or the like. When ordering this type of instrument, the following information should be substituted for Item 4:

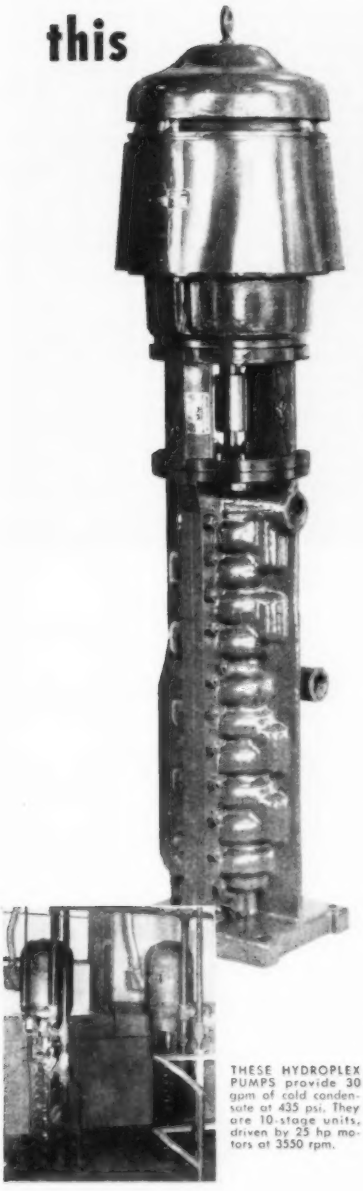
4. Pressure measuring element, volumetric systems only:
a. Pressure:
1) Range (including suppressed—specify) and "normal" operating pressure.
2) Maximum possible and anticipated overrange. (To provide overrange and safety protection, etc.)
b. Material of construction:
1) Diaphragm. (See catalogs; usually stainless steel, copper, monel, etc.)
2) Capillary. (Specify material, distance from element to instrument, elevation of diaphragm vertically from level of instrument, minimum ambient temperature for capillary and case, respectively.)
3) Diaphragm mounting flange. Select from catalog; specify any special materials, also size and drilling if different from "standard."
c. Pressure base.

Data required when ordering liquid level control instruments

Level measurement may be accomplished in a great many ways, ranging from the conventional float (buoyancy) or displacement types through differential pressure measurement of the hydrostatic head; use of probes depending on capacitance conductivity and the like, and absorption of radiation. In the oil industry the usual method involves the float, displacement and measurement of hydrostatic head by differential pressure methods. In the latter case, the instrument may be considered identical to the measuring element of the differential-pressure flowmeter, although calibrated differently. This discussion is limited to these types.

There are various methods for transducing the mechanical movement of the float and displacement types of

this small, low-priced



THESE HYDROPLEX PUMPS provide 30 gpm of cold condensate at 435 psi. They are 10-stage units, driven by 25 hp motors at 3550 rpm.

BJ HYDROPLEX PUMP

is *engineered* for economical boiler feed service

- For medium pressure, medium temperature, low capacity pumping.
- Uniform, non-pulsating flow.
- Variable capacities without by-pass or speed change.
- Vertical construction—needs only a simple foundation and a minimum of floor space.
- No relief valves.
- Only one stuffingbox . . . and it is under suction pressure.
- Radial forces balanced at all loads by staggered volute construction.
- Axial thrust balanced by opposed grouping of impellers.
- Easily dismantled and reassembled.

IF YOUR PUMPING JOB involves a medium pressure, medium temperature, low capacity operation, the BJ Hydroplex can do it with quiet, smooth efficiency *and with less installation and maintenance cost.* This smaller, low-priced version of the highly successful BJ Hydropress centrifugal pump has a capacity range from 10 to 140 gpm at heads of 450 to 1700 feet. It operates at high speeds—3550 rpm on 60 cycle and 2950 on 50 cycle and higher in special units.

You'll find that this simple, dependable BJ Hydroplex has definite advantages over complex displacement type pumps. For full information, send the coupon now.

BJ PUMP DIVISION, DEPT. 27

Our problem is pumping _____ gpm of _____
at a head of _____ Tell me more about the BJ Hydroplex.

NAME _____

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No obligation, of course.

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(To obtain more data on advertised products see page 1292)

level controls into terms of controller air flow or electrical energy to transmit level reading to a distant receiver or actuate some type of control valve. The mechanically linked type which directly actuates a valve with or without indicating or recording is not included in this discussion, having been previously treated in this series as a part of Article 2 on automatically actuated valves. The following information is required for odering:

1. Type of controller or indicator. (Manufacturer's figure number if known; otherwise note whether displacement, float, differential pressure or other specified type).
2. Nature of fluid:
   a. Name.
   b. Specific gravity or density (at stated conditions; best also to give at operating conditions unless a well-known material for which published data are available. If interface level involved, give data for both liquids.
   c. Corrosive? (Suggest resistant materials.)
   d. Temperature—maximum and operating; minimum also when below 0°F.
3. Measuring element:
   a. Location. (Vessel geometry—e.g. side or top of tank, liquid leg, reboiler, etc., giving allowable space to install element. Detailed drawing is excellent.
   b. Float or displacement unit size (when known). (Select materials when choice given catalog standard material unacceptable or leave to manufacturer. Depends on density of fluid and corrosive nature, normally.)
   c. Tube (Bourdon or torque), diaphragm or bellows material (as in "B" above.)
   d. Range (any units.)
   e. Operating and maximum pressure.
   f. Stuffing box construction and packing. (Specify only when "standard" unacceptable because of special conditions, or when choice given.)
   g. Connections (normally flanged):
      1) Size, drilling, class.
      2) Material (select only when option given or specify because of special operating conditions.)
4. Controller:
   a. Action: Increasing level to open or close valve.
   b. Type of action: Throttling or open/close within range.
   c. Power failure—valve to open or close on air or electrical failure.
   d. Power supply. (Air pressure or electrical characteristics.)
   e. Control setting. (Manual, automatic or combination.)
   f. Control response. (Proportional, automatic or manual, reset, and optional combinations.)
   g. Distance (feet) between measuring and control elements for pneumatic transmission. (Valuable in compensating for response lag.)
5. Indicator recorder:
   a. Scale or chart calibration. (feet, gallons, percent, other.)
   b. Contact points, (usually optional, may substitute for or combine with Item 5A to actuate high- and low-level alarm, etc.
   c. If Recorder, select.
      1) Chart drive and speed (per catalog.)
      2) Pens, multicolored dots or numerals, etc.
6. Accessories. (Supply air filters, regulators, etc., if optional and manufacturers to supply; charts; pens; piping, etc.)

Data required when ordering pressure actuated pilots

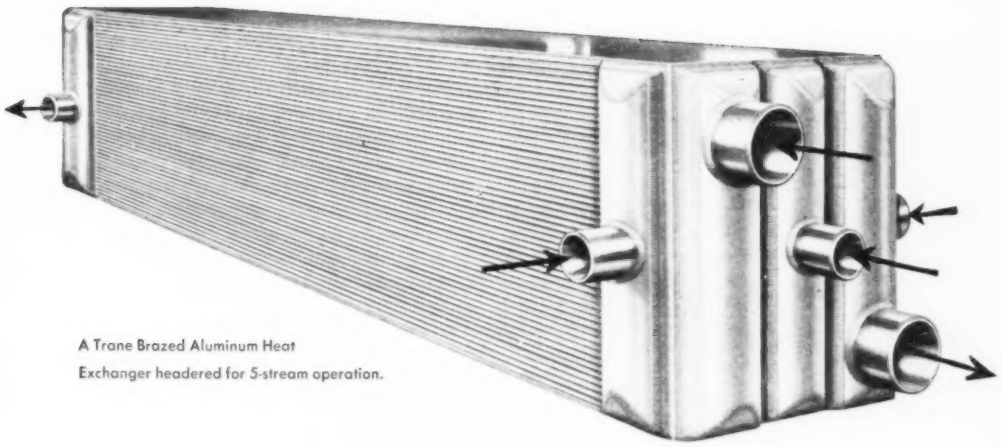
Pilots may be used for any type of measurement to actuate control valves of the diaphragm motor type or transmit signals to or from a recorder or controller. They may measure differential head and thereby become level controllers or utilize pressure of the controlled fluid and regulate pressure. Less commonly the pressure is that of a thermal bulb and thereby temperature is controlled.

In any event pilots are essentially pressure measuring diaphragms or bellows, or are based on the Bourdon tube and its modifications in the spiral or helical versions. By the movement of the pressure measuring element, pressure of controlled air to the valve is adjusted or (less commonly) electrical contacts made.

Pilots are frequently used with level controllers, the pilot in effect becoming a transmitter to the valve. The pressure element in this case is replaced by a mechanical linkage to the level instrument, in order to make the latter more sensitive or reduce its size.

The data below apply only when pilot is ordered separately from regulator, level controller or similar device:

1. Type. (Catalog figure number.)
2. Application (Pressure regulator, level controller, etc.)
3. Pressure: (When applicable.)
   a. Operating range.
   b. Maximum or minimum.
4. Nature of fluid, corrosive character, presence of solids, operating and maximum temperatures. (Omit when pilot actuated, by mechanical connection to level indicator.)
5. Measuring element:
   a. Type—when optional in catalog. (Diaphragm, bellows, etc.)
   b. Material of construction.
   c. Connections—screwed, flanged, etc. (Give size, drilling, rating; specify bottom side, etc. when optional.)
6. Pilot action:
   a. Direct or reverse-acting.
   b. Action on air-failure.
   c. Supply air pressure.
   d. Pressure required to stroke control valve.
7. Accessories. (Usually includes pressure gages, travel indicator filters, external air pressure regulators, valve positioners, etc.)



A Trane Brazed Aluminum Heat Exchanger headered for 5-stream operation.

This Single Brazed Aluminum Heat Exchanger

Handles FIVE Fluids Simultaneously

Trane Brazed Aluminum Heat Exchangers can be designed to handle up to five streams, or even more, at the same time – and meet the heat transfer needs of each stream accurately and efficiently.

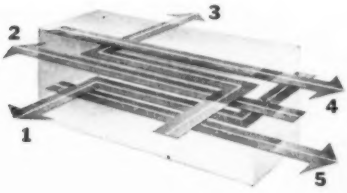
A single unit can be made to handle two, three, four, five or even more different liquids or gases. Headers are designed specifically for your installation. You can take any stream off at any point in the exchanger. You can split a stream, taking part off at one point in the unit at a given temperature and pressure, the rest off at another point at different conditions. The units provide just the heat transfer, pressure drop, volume, velocity, number and direction of passes needed for each stream.

And the units can meet these heat transfer specifications in the most limited space. That's because the Trane Brazed Aluminum Heat Exchangers pack up to 450 square feet of heat transfer surface into one cubic foot – nine times more than a tubular exchanger with ¾" tube.

Since a smaller unit can do a bigger job, *Brazed Aluminum Heat Exchangers can often replace tubular exchangers costing two or three times more and weighing four times more.*

These all-aluminum Trane Heat Exchangers are rugged, too. They take test pressures up to 1,000 lbs. per square inch, and temperatures from –300° to 500°F.

Whether the job calls for high or low temperatures or pressures, for one stream or many – as long as efficiency and economy are important – Trane Brazed Aluminum Heat Exchangers can be the answer. Contact your nearest Trane sales office or write direct.



Symbolic drawing, left, shows one of many ways in which a Trane Brazed Aluminum Heat Exchanger may handle up to five fluids simultaneously.

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MANUFACTURING ENGINEERS OF HEATING, VENTILATING AND AIR CONDITIONING EQUIPMENT

Data required when ordering indicators, temperature and pressure

Although the rise of recording and controlling instrumentation in refinery and natural gasoline plant has been great, there still are many applications for the familiar thermometer and pressure gage. These are among the oldest "instruments" known to industry; yet all too often buyers fail to give adequate information in ordering them. Perhaps this in in part due to their being taken for granted or in the mistaken belief these instruments have reached the ultimate in development and no further improvement is possible.

In the past few years there have been many improvements in pressure gages, for instance, which improve their accuracy and sensitivity, extend the pressure range or reduce maintenance. Some have adopted the snap ring as preferable to the screwed bezel, which often corroded and froze, making removal difficult for access to the pointer; others now have an external "zero" adjustment.

Thermometers have been improved, both in the mechanical and glass tube type as to ruggedness, readability and to some extent, extension of range. Other improvements include compensation for ambient temperatures and better over-range protection. Some also can be equipped to give high-low alarms or actuate control devices.

THERMOMETERS

The following applies to both glass tube and dial type thermometers, wherein the measuring fluid is visible (as mercury, alcohol, etc.) or the thermal element (bimetallic strip, fluid filled helical tube and similar arrangements) is mechanically linked to the indicating mechanism. Laboratory glass type thermometers normally are specified in the various standard test methods and hence it is sufficient to refer to the test method (e.g. ASTM Saybolt Viscosity) and state desired temperature range where manufacturer's catalog number is not available. The following information is required when ordering thermometers.

1. Catalog, model, or figure number. (This will differentiate between the various dial or direct reading types, tank thermometers and the like, though it may not separate armored and unarmored tubing and bulbs.)

2. Application. (Where catalog number is unavailable, undesirable or manufacturer's recommendations are invited, this must be given. It is always advisable as a double-check against selection in Items 1 and 3.)

3. Measuring element:
   - a. Range, °F. or °C.
   - b. Actuation. (Specify mercury, vapor tension, gas filled, bi-metallic helix, spring, when catalog option is given.)
   - c. Length of capillary tubing between bulb and indicator. (Especially when manufacturer's standard length is exceeded.)
   - d. Bulb and socket:
     - Type bulb. (Plain, finned, armored, rigid stem, angle type, etc.)
     - 2) Length. (Of stem—note how length is measured in catalog.)
     - 3) Type connection. (Specify union, flanged, extension union or flanged; thread options.)
     - 4) Socket: (Specify by number or state standard, extension neck or other option.)
       - a) Length. (Note how measured, from catalog.)
       - b) Material. (Brass, stainless steel, carbon steel or other—similar to thermowell. If unknown, state corrosive nature of fluid and pressure; other materials in contact with fluid, "normal" temperature; whether or not an electric current is present—i.e. cathodic protection, stray currents, etc.)
       - c) Thickness. (Only when other than standard.)
       - d) Installation. (Pipe—give, diameter—furnace, vessel, etc.) (When manufacturer's recommendations desired.)

4. Head or Indicator.
   - a. Flush, adjustable or wall mount. (Include case details when options available—e.g. case finish, etc.)
   - b. Temperature. (For compensation purposes; also some manufacturers desire to know if in excess of a certain temperature. This is not stem temperature.)
   - c. Stem location with respect to dial, when optional and different from standard. (Not necessarily specified by model numbers.)
   - d. Scale size or head dimensions. (See catalog.)

5. Accessories (see catalog). (Handles, cases, extra sockets, etc. Note: For panel mountings, some manufacturers request mounting dimensions, board thickness.)

6. Contact-making thermometers only, specify ratings for contacts, on-off or differential service and details of load, or see catalog.

PRESSURE GAGES

Information required for ordering:

1. Catalog or figure number, and type.

2. Pressure range (Advise if steady or pulsating.)

3. Nature of fluid. (Name, corrosive possibilities, type of service.)

4. Temperature of service. (Normal and maximum.)

5. Measuring element:
   - a. Type. (Helical, Bourdon tube, diaphragm, etc.)
   - b. Material. (Brass, bronze, stainless steel, etc.)
   - c. Connections. (Case to service.)
   - d. Range. (Consider over-range possibilities.)

6. Case:
   - a. Size.
   - b. Dial graduations or range. (Specify or order standards by numbers.)
   - c. Location of connection with respect to case.
   - b. Material and construction (See catalog. Includes finish, type mounting, safety blow-outs, shatterproof glass, reference pointer, electric contacts for alarms or control.)

7. Accessories. (see catalog.) (Includes snubbers, cocks, coils, filters, etc.)

Data required when ordering instrument parts

Generally the ordering of parts is extremely simple if ordering care is used. Most manufacturers give parts information ordering details in their catalogs or in parts lists supplied with the instrument. Further, except for pressure gages and thermometers, the manufacturer keeps on permanent record the model number and serial number of instrument supplied to a customer and this always should be stated.

1. Model and serial number.

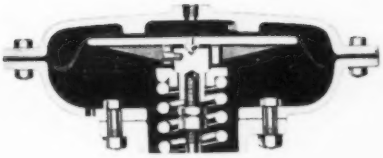
2. Part number and good description. (This will help catch typographical errors and mistakes. A catalog photograph or parts catalog photo is an excellent substitute for description.)

3. Date of catalog or parts list used.

* COMPARE

THIS FEATURE

OF THE HONEYWELL SERIES "700" VALVE



Pre-Molded Neoprene Diaphragm, with rolling action. Eliminates wrinkling or buckling . . . responds to slightest change in signal air pressure . . . withstands excessive pressures . . . available with cotton or nylon reinforcement . . . permits use of gas as actuating medium.

Duplex Upper Stem Guide

Packless Bellows Seal

Safety Stem Lubricator

One-Piece Bonnet

Wide Variety of Discs

Reversibility in the Field

* Compare the diaphragm assembly of this valve with that of any other wide band proportional type. Look at it closely . . . study it feature by feature.

Then check the other features of the valve . . . the Duplex Stem Guide, the One-Piece Bonnet, the Packless Bellows Seal, the Safety Stem Lubricator, the wide variety of discs, the easy reversibility in the field from direct to reverse acting, or vice versa.

Your comparison will prove that the Honeywell Series 700 has *all* the features you look for in a fine valve.

It's available in a wide range of styles and sizes. For detailed information, write for a copy of Bulletin 750 or call in your local Honeywell engineer . . . he is as near as your phone.

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Valve Products

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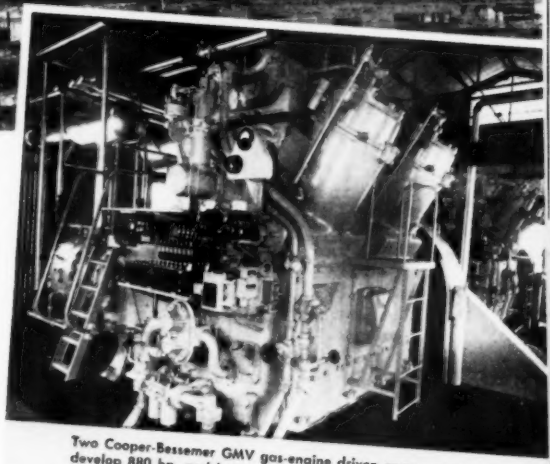
IT'S FROM "Oilwell"

...down to the last nut, screw and bolt!



Two Cooper-Bessemer GMV gas-engine driven compressor units develop 880 hp. and have capacity to deliver 5,000,000 cu. ft. of gas at 450# pressure.

This complete GATHERING SYSTEM and GAS BOOSTER STATION

(Located in West Beaumont, Texas, Field)

. . . gathers gas that was formerly "flared"; then compresses and delivers it at 450# pressure to commercial gas lines. All operations are automatically controlled and require the supervision of only one attendant.

In addition to the building, cooling tower, scrubbers and compressor equipment shown, this installation includes a 6-mile gathering line system consisting of pipe sizes from 2" to 8", as well as a residence on the lease for the supervisor.

It was designed and constructed by Deerfield Petroleums, Inc. and is being operated by Universoil, Inc. All equipment and material was supplied by "Oilwell" . . . enabling the contractor as well as the operator to centralize procurement details at a single convenient source.

Discover for yourself...

. . . the many advantages of shifting procurement responsibilities to a long-established, fully-integrated company, specializing in supplies for the petroleum industry. The next time you undertake a development project of this type . . . bring your problem to "Oilwell."

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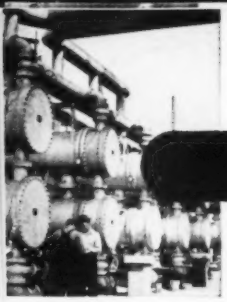
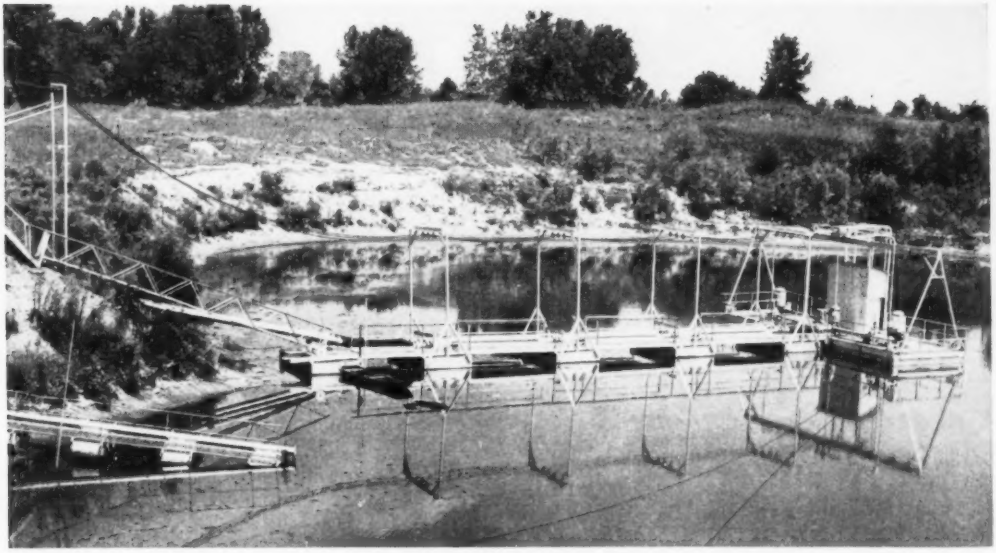


Sand Pit Is Water Supply—No Wells Needed



Floating pumps in an abandoned pit fulfill Ohio Oil's refinery water requirements, eliminating well-digging problem

INTAKE pumps mounted on a steel barge floating in an old abandoned sand and gravel pit have eliminated a water supply headache for Ohio Oil Co. in the operation of its Robinson, Ill., refinery. The floating pump barge is shown above.

Up until five years ago, the company's water supply had consisted of a series of conventional wells located at a point about six miles east of the refinery. This system presented a continual problem of digging a new well every four or five years, chiefly because the well casings would plug up with sand. Then, in 1946, this source was supplemented by placing a small barge with one pump on it in the nearby abandoned pit, some 100 yards or so to the northeast. The arrangement was maintained as standby equipment for about a year.

The present barge was built and put into service in 1947. The original wells were then taken out of service completely except for standby purposes. Equipment on the barge comprises three deepwell, multi-stage, centrifugal pumps; two rated at 900 gpm., one at 450 gpm. They are driven by 440 volt motors; 125 hp on the 900 gpm. pumps, 75 hp. on the smaller one. Normal requirements at Robinson are in the range of 1200-1300 gpm. water. One large and the small pump will therefore suffice for average demands. However, a total of 2250 gpm. is available for peak loads.

Intakes are Screened

Pump intakes are just below the bottom of the barge and are screened. Discharge from the pump manifold is through two 12-in. lines all the way to the refinery. Flexible connection between barge lines and those on shore is by two pieces of 12-in. rubber, barge-loading hose.

The pit is approximately 40 ft. deep. Water level fluctuates over a range of about 8 ft. The barge is kept in position by four steel cables running from the four corners of the barge to points on the shore. The cables are kept taut by means of hand winches.

Normally, water seepage into the pit will keep abreast of the 1200-1300 gpm. pumpout. However, Ohio Oil has a supplemental pit about one mile north, for use in case pumpout becomes excessive. A 500-900 gpm. pump at the auxiliary pit sends water through an 8-in. line to the main pit.

Upkeep has been negligible on the set-up. About four years ago it was found necessary to dredge the pit of sand accumulation. Following that project, no further work has been required. The company is now building a new two-barge unit which will mount two combination, gasoline-electric deepwell, 900 gpm. multi-stage centrifugal pumps. Electric drive will be by 2300 volt motors. Gasoline drive will be by Waukesha No. 6WAKE engines. It is planned to locate a gasoline storage tank up on the bank of the pit for gravity feed of fuel to the engines. The purpose of the combination units is to insure water supply in case of an emergency due to power failure. Power is obtained from the refinery power plant at Robinson.

Portable Gantry Saves 2 Hrs/day

BUILT from scrap materials for an estimated $180, a portable gantry to handle maintenance on tank car trucks saves an average of two hours daily for Socony-Vacuum Oil Co., Inc., at its tank car repair department in Kansas City, Kans. It has eliminated the time previously wasted in waiting for the large overhead, electrically-operated crane, allowing that unit to be used for the heavier jobs for which it was designed.

The gantry is shown in the accompanying sketch, Fig. 1. It was constructed of $1\frac{1}{2}$-in. pipe, $1\frac{1}{2}$-in. angle iron, 1-in. strap iron, and $\frac{1}{2}$-in. pipe. Two pieces of plate were also used. The basic design is that of a horizontal truss supported by two "A" frames. The angle iron forms the base of the truss and also serves as a track for the two travelling suspended turnbuckles and the one travelling chain jack type hoist. The complete gantry is light enough for two men to move it readily around the repair yard, carrying it by the four "fold-away" handles.

In use, the gantry is placed over a tank car truck. Once in place, it enables a single workman to complete the job of disassembling the truck for repairs or replacement of parts. With the chain hoist, he can lift the entire truck bolster for removal of the truck springs and spring plank. With the two end turnbuckles, he can remove the wedge and brass.

In use for over a year now, the unit was suggested and devised by John W. Lee of the Kansas City shops.

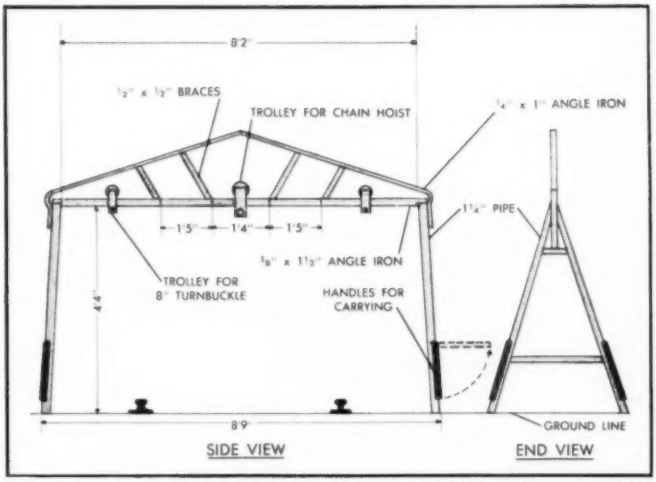


Fig. 1—Side and end views of Socony's portable gantry

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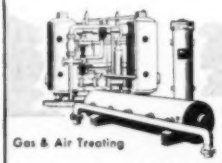
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Shell's fuel oil additive saves money four ways for refiners:

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Ionad 17 is a stable concentrate that is readily soluble in fuel oil stocks. It prevents the agglomeration of the tars and resins that form in most fuel oils from the polymerization of olefins. Its advantages are now available to refiners of fuel oils—get complete information from the nearest Shell Chemical office.

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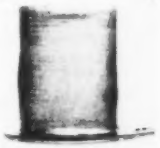
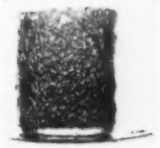
WITH IONAD 17



WITHOUT IONAD 17



Both filter screens operated for 28 days with No. 2 fuel oil.

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IONAD 17

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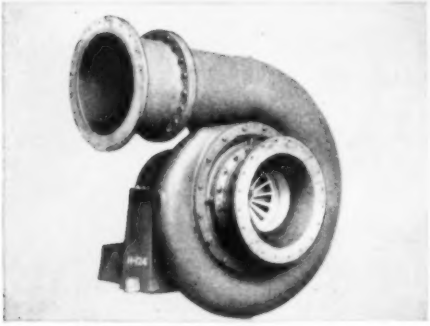
WHEN SELECTING
BLOWERS



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Type OI Centrifugal Blower in southwestern refinery. Capacity 13,000 cfm.

You can't afford to risk shutdowns today because of unsatisfactory or inadequate equipment performance. To keep production moving at the required fast pace, calls for blowers or gas pumps that continuously deliver positive Volume at required Pressure—and at Low power costs to reduce operating expense.

You get these 3 essentials from R-C Blowers and Gas Pumps. Whether your needs call for Centrifugal or Rotary Positive units, we can match them from our exclusive *dual-ability line*. With capacities from 5 cfm to 100,000 cfm, you can usually find R-C units that closely fit your demands, with resultant savings in time, cost, space, weight and power.

From an experience of almost a century of blower building, our engineers will gladly make suggestions of the right R-C equipment to move or measure gas and air to keep production going.

ROOTS-CONNERSVILLE BLOWER CORPORATION
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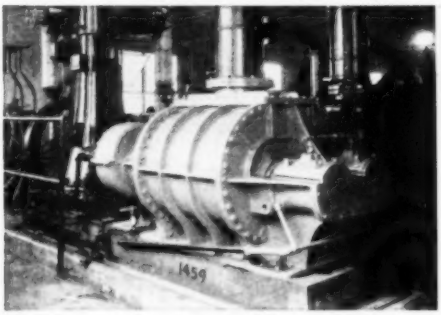

ROTARY

Rotary Positive Gas Pump for handling refinery gas. Capacity 3,100 cfm.

ROOTS-CONNERSVILLE
BLOWER BUILDERS SINCE 1854
ONE OF THE DRESSER INDUSTRIES

"Bone Crusher" Controls Caustic

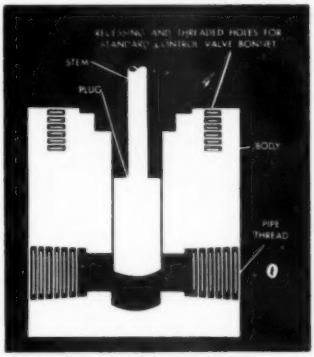

Fig. 2—Caustic Flow control problems were licked with this re-designed valve

*By E. D. MATTIX and W. O. SUYDUM**

A PROBLEM in controlling flow of 50° Be. caustic solution in the Unisol treating unit at Cities Service Refining Corp.'s Lake Charles, La., refinery has been solved by the use of a home-engineered control valve referred to by plant instrument men as the "bone crusher."

It had been found rather difficult to measure and control the flow of the caustic with conventional instruments due to the tendency of the caustic to crystallize and due to materials that deposited out of the caustic. The original installation consisted of a conventional mercury manometer-type flow controller with a double-seated, parabolic plug control valve. Maintenance on the mercury manometer seals was excessive and the control valve had a strong tendency to bridge slowly over the ports with crystallized caustic and debris, until the valve was wide open, when a slow reduction in caustic flow rate occurred.

The control problem was solved by designing a piston type valve (see Fig. 2). It consists of a commonly-used control valve diaphragm and yoke along with the newly-designed valve body with a cylindrical plug. Tight shut-off was not essential. A somewhat balanced plug was obtained by cutting a slot on the downstream side of the plug. This equalized the pressures on the top and bottom of the plug.

The mercury manometer was re-

*Mr. Mattix is technical assistant to operating superintendent, Cities Service Refining Corp., Lake Charles, La., refinery. Mr. Suydam is instrument foreman.

placed with a Foxboro d/p Cell, mounted as close as possible to the orifice flange with no other supports than the meter piping. After steam tracing the installation, we found the measurement problem was whipped.

The above short article is based upon a portion of a paper, "Refinery Control Problems," presented by Mr. Mattix at the Sixth Annual Instrument Conference, Houston, Texas, Sept. 10-14, 1951.

Safe Way for Greasing Manual Boiler Dumps

THE central power plant at the Olean, N. Y. refinery of Socony-Vacuum Oil Co., Inc., has three boilers with hand-operated dumps which must be unloaded at least once each shift. In addition, the fires have to be shaken by hand an average of four times per hour, since that is the only means of agitation.

The mechanism for performing these jobs is covered with a large sheet metal guard, measuring approximately 68 x 30 x 31 in. To grease the shaker and dump arms the workmen must remove this guard, and it is heavy, awkward, and the underside is very hot. Also, this exposes the complete unit which likewise is hot.

A suggestion made by John H. Quinn, of the power plant force, and adopted by the company, has eliminated the danger of injury of burn and still permitted regular lubrication of this equipment. It consists simply of installing two small, 6-in. square doors on top of each guard and directly over the grease cups.

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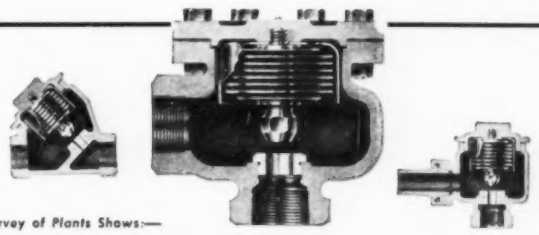
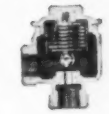


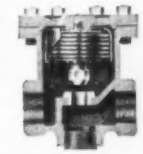
Survey of Plants Shows:—

15 of 20 Engineers Prefer Nicholson Traps

To determine the best steam trap on which to standardize, a large processing firm recently asked their plant engineers for their preference. In 15 out of 20 plants the choice was Nicholson.

The repeated adoption of Nicholson steam traps in plants currently in big "cost-reduction-through-modernization" programs is another indication of their advanced features. To learn why an increasing number of leading plants are standardizing on Nicholson thermostatic steam traps send for our catalog. 5 types for every power, heat, process use; size ¼" to 2"; press. to 225 lbs.





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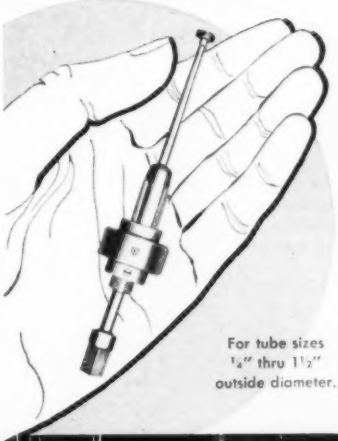

For tube sizes ¼" thru 1½" outside diameter.

These precision Ideal Tube Expanders are unequaled for rolling tubes in Condensers, Coolers and other heat-transfer units. The Ball Bearing, adjustable thrust collar reduces friction to a minimum. You get every desirable feature—plus—in No. 255.

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THE GUSTAV WIEDEKE COMPANY
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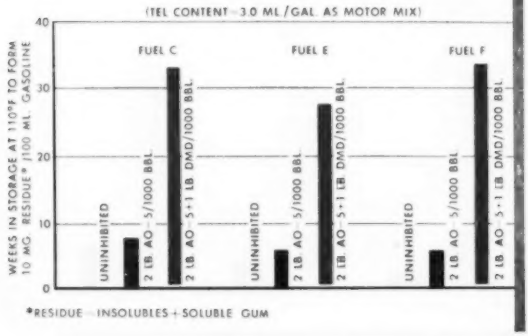
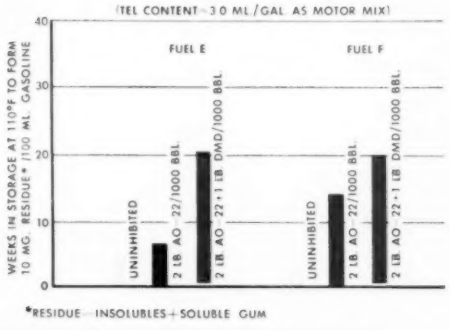
(To obtain more data on advertised products see page 1292)

EFFECT OF DU PONT METAL DEACTIVATOR IN COMBINATION WITH ANTIOXIDANT No. 5 IN 3 GASOLINES



*RESIDUE—INSOLUBLES + SOLUBLE GUM

EFFECT OF DU PONT METAL DEACTIVATOR IN COMBINATION WITH ANTIOXIDANT No. 22 IN 2 GASOLINES



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COMPOSITION, COPPER CONTENT, AND DEACTIVATOR RESPONSE OF TEST FUELS CITED

FUEL COMPOSITION

	Composition, vol. %		
	Fuel C	Fuel E	Fuel F
Catalytic cracked gasoline	30.0	46.0	75.0
Thermal cracked gasoline	13.4	32.0	5.0
Straight run gasoline	56.6	22.0	—
Natural gasoline & light ends	—	—	17.0
Thermal reformed gasoline	—	—	3.0
Copper content p.p.m. by wt.	0.04	0.03	0.05

INDUCTION PERIOD RESPONSE TO METAL DEACTIVATOR

Metal Deactivator Concentration, wt. %	Induction Period, min.		
	Fuel C	Fuel E	Fuel F
None	1078	404	971
0.0001	1159	398	1036
0.0003	1174	407	1035
0.0005	1171	406	1029
0.0008	1170	401	1030

DU PONT METAL DEACTIVATOR STEPS UP STORAGE STABILITY OF MANY GASOLINES

There is a good chance that copper is present in your gasoline whether any of the components have been copper sweetened or not. Recent tests at the Du Pont Petroleum Laboratory, for example, show that 64 out of 91 samples of gasoline components tested contained copper.

Since an antioxidant alone does not always provide the required stability over extended storage periods when copper is present, the use of an economical additive such as Du Pont Metal Deactivator *in conjunction with the antioxidant* is recommended.

The above data illustrate the point. As the charts show, with only 1 lb. of Du Pont Metal Deactivator per 1000 barrels added to antioxidant inhibited gasolines stored at 110° F., the stability period increased from 6-8 weeks with antioxidant alone, to 28-34 weeks with Metal Deactivator added, before reaching a 10 milligram residue level.

If you are interested in insuring the storage stability of your gasoline at a minimum cost, we suggest, for more accurate results, you use storage tests rather than accelerated tests to determine the value of Du Pont Metal Deactivator combined with Du Pont Antioxidants in your stocks.

For samples or further information get in touch with your Du Pont representative.

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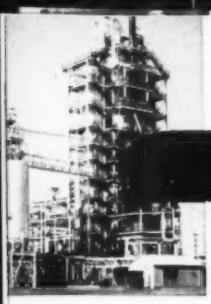
(To obtain more data on advertised products see page 1292)



PROCESSING PATENTS

New Developments in Processes and Products

By PETER J. GAYLOR, Patent Attorney
Gaylor, Cifelli & Jurick, Newark, N. J.

Acidic Sulfur-Containing Compounds Inhibit Alkaline Corrosion of Copper

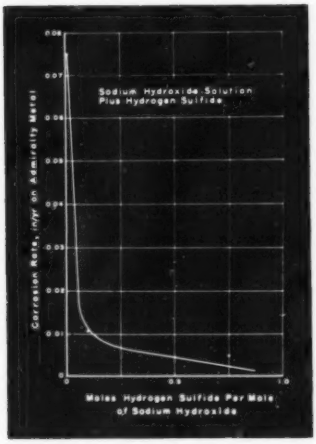


Fig. 1—Inhibiting alkali corrosion of copper (e.g., heat exchanger tubes), with the addition of hydrogen sulfide (U.S. 2,550,434)

IN MANY commercial operations involving the processing of fluids, the fluid becomes contaminated by acid which causes rapid corrosion. To reduce the acidity of the fluid and render it less corrosive, it is desired to add an alkaline agent.

However, the equipment employed in handling the fluid is usually not made of a single metal but includes several dissimilar metals. While the walls of vessels and piping connecting vessels may be made of steel, it is common to use copper in conjunction with the units. Heat exchangers may have shells made of steel while the tubes are of copper or Admiralty metal; although the addition of an alkaline agent to the acid-containing fluid may reduce corrosion of the ferrous parts, the contact of the alkaline reagent with copper may cause corrosion of this metal at a relatively rapid rate.

In its U. S. 2,550,434, Standard Oil Development Co. proposes to suppress the corrosion of copper surfaces caused by alkaline components in aqueous solutions by the addition to these solutions of an acidic sulfur-containing compound which should be added in an amount in excess of a predetermined minimum. This minimum may be expressed in terms of the molar ratio of acid-reacting sulfur compounds to alkaline reagents in solution, or in terms of the ratio of the phenolphthalein end point to the methyl orange end point. The most satisfactory results are obtained when the solution has added to it no less than 0.1 mole of acidic sulfur-containing compound for every mole of alkaline reagent present in the solution.

Specific examples of acidic sulfur-containing compounds, suitable as inhibitors, are hydrogen sulfide, sulfur dioxide and mercaptans. The marked reduction in corrosion rate may be deduced from the curve shown in Fig. 1 depicting the effect of added hydrogen sulfide to sodium hydroxide with respect to corrosion of Admiralty metal.

Reforming Catalyst Contains Only 0.01 to 1% Platinum

IN one of our recent columns (August 1951, p. 887) details were given from an Atlantic Refining Co. patent dealing with a platinum reforming catalyst. Since that time, a patent (U. S. 2,566,521) was issued to Universal Oil Products Co. on a platinum catalyst for the same purpose.

This latter patent points out that the cost of such catalysts is directly proportional to the platinum concentration. Thus, if it is possible to reduce the amount of platinum from 5% to 0.1% by weight, the cost of the catalyst is reduced by at least 50 times.

As in the case of Atlantic Refining Co., it was found that alumina is the best support, apparently due to some peculiar association of the alumina with the platinum. However, the similarity ends there, because the UOP patent specifies the commingling of a halide and a platinum oxysulfide with the alumina. In fact, it is essential that the final catalyst contain halogen in a specific concentration in combination with the other constitutents.

In preparing the catalyst, it is preferable to employ aluminum chloride for making the aluminum hydrate which is washed as free as possible of halogen. About 0.05-0.5 mole of acetic acid is added per mole of hydrate to peptize the gel. Then aqueous hydrofluoric acid is added so that 0.1-3% of combined fluorine is present in the alumina on a dry basis.

Thereafter, chlorplatinic acid, previously treated with hydrogen sulfide, is mixed into the gel and stirred intimately, and the completed mixture is blown with air until the platinum is in the form of the oxysulfide. The finished catalyst contains 0.01-1% by weight of platinum.

After a drying and pelleting operation, the catalyst is subjected to calcination at 800°-1200° F. for 2-8 hrs. The reforming reaction is conducted at 600°-1000° F. and 50-1000 psi. in presence of recycle hydrogen.

Regenerating Caustic Solutions

SOCONY-VACUUM Oil Co. describes a process for utilizing caustic, spent in hydrogen sulfide removal, for stabilizing oils "sweetened" by doctor treatment. Such doctor "sweetened" oils generally deposit a sediment during customer storage. It has been found that the "sweetened" oils can be stabilized against deposit formation by contacting the oil with spent caustic from hydrogen sulfide scrubbing. This treatment is claimed to regenerate the caustic, making it suitable for again scrubbing out hydrogen sulfide, whereas otherwise it would have been discarded (U.S. 2,515,141).

Patents Issued in September

The following classified listing gives the patent number, patentee or assignee, and a brief description of all patents believed to be of interest to the petroleum processing industries, as contained in the Official Gazettes of the U. S. Patent Office for September 4, 11, 18 *and* 25, *Vol.* 650, *Nos.* 1-4.

Specialties

2,566,298 (Standard Oil Co.—Ind.) Cleaning Composition.
2,566,815 (Shell Development Co.) Epoxy-hexenylidene and insecticidal compositions thereof.
2,568,946 (Gulf Research & Development Co.) Manufacture of paraffin waxes.

Hydrocarbon Synthesis

2,566,311 (M. W. Kellogg Co.) Separation of organic compounds.
2,566,620 (Phillips Petroleum Co.) Manufacture of synthesis gas.
2,567,596 (Phillips Petroleum Co.) Synthesis of hydrocarbons.

2,567,295 (Standard Oil Development Co.) Synthesis of hydro-carbons with a reduced gamma iron oxide catalyst.
2,567,296-7 (Standard Oil Development Co.) Preparation of a Fischer-Tropsch catalyst.
2,567,932 (Hydrocarbon Research, Inc.) Stage-wise process for the hydrogenation of carbon monoxide.
2,568,717 (M. W. Kellogg Co.) Separation of oragnic compounds.
2,568,841 (The Texas Co.) Method of synthesizing gasoline hydrocarbons.
2,568,953 (M. W. Kellogg Co.) Process for the synthesis of organic compounds.
2,569,384-5 (Standard Oil Development Co.) Recovery of oxygenated compounds from hydrocarbon oils.

Conversions

2,566,337 (Universal Oil Products Co.) Method of controlling exothermic catalytic gas reactions.
2,567,207 (Houdry Process Corp.) Maintenance of catalytic activity in hydrocarbon conversion systems.
2,567,259 (The Texas Co.) Catalytic conversion with a fluidized solid catalyst.
2,567,283 (The Texas Co.) Manufacturing motor fuels by polymerization and alkylation.
2,568,964 (Gulf Research & Development Co.) Catalytic isomerization of olefinic hydrocarbons with HF-alumina.
2,568,967 (Gulf Research & Development Co.) Thermal cracking process.

Refining

2,566,353 (Houdry Process Corp.) Purification of oils with base-exchange resins.
2,566,613 (Phillips Petroleum Co.) Aromatic recovery process using silica gel.
2,567,172 (The Texas Co.) Method of refining fuel oil with a solvent.
2,567,173-4 (Standard Oil Development Co.) Extracting fuels with acid containing aldehyde.
2,567,175 (Standard Oil Development Co.) Desulfurization and sweetening of virgin distillates with an aldehyde.
2,567,228 (Standard Oil Development Co.) Extractive distillation of close-boiling hydrocarbon fractions with hydrotropic solutions.
2,567,252 (Anglo-Iranian Oil Co. Ltd.) Desulfurizing hydrocarbons with H_2S recycle.
2,567,616 (The Texas Co.) Low-temperature separation of oil from wax involving initial chilling in a film-type chiller.
2,568,115-7 (Petrolite Corp., Ltd.) Processes for breaking petroleum emulsions.
2,568,159 (American Cyanamid Co.) Recovery of dicyanodialkyl ethers and sulfides used as solvents in an aromatic hydrocarbon extraction process.
2,568,517 (Stanolind Oil and Gas Co.) Extraction of organic oxygenated compounds from hydrocarbon mixtures.
2,568,738-46-8 (Visco Products Co.) Process for resolving emulsions.
2,569,216 (Standard Oil Development Co.) Separation of olefins from hydrocarbon distillates containing aromatics.
2,569,370 (Standard Oil Development Co.) Method for treating petroleum distillates with naphthenic acid.

Chemicals

2,566,355 (Jefferson Chemical Co.) Preparing olefin chlorohydrins.
2,566,515 (Universal Oil Products Co.) Drying oil composition.
2,566,537 (Universal Oil Products Co.) Peroxide catalyzed polymerization of ethylene in the presence of a phenolic compound.
2,566,538 (Universal Oil Products Co.) Peroxide catalyzed polymerization of ethylene in the presence of an amino compound.
2,566,810 (Shell Development Co.) Sulfoacetic acid anhydrides and methods for their preparation.
2,566,992 (Standard Oil Development Co.) Manufacture of imides.
2,567,015 (Standard Oil Development Co.) Hydrocarbon rubber plasticized with a polyvinyl compound.
2,566,792 (Shell Development Co.) Stabilization of unsaturated ketones.
2,567,244 (M. W. Kellogg Co.) Dehydration of organic acids.
2,567,254 (Sinclair Refining Co.) Process for preparing nitriles and pyridines.
2,567,243 (Phillips Petroleum Co.) Resinous products from HF acid-soluble oils.
2,567,399 (Standard Oil Co.—Ind.) Purifying sulfonic acids.
2,567,541 (Swift & Co.) Manufacture of higher alcohols using liquefied normally gaseous hydrocarbons.
2,567,645 (Shell Development Co.) Producing a detergent composition.
2,567,675 (Shell Development Co.) Plastic compositions from copolymers of unsaturated esters of ethereal oxygen-containing acids.
2,567,848 (Shell Development Co.) Alkylation of phenolic compounds with olefins.
2,567,854 (Shell Development Co.) Production of alkyl aromatic sulfonic acids and their salts.
2,568,095 (Standard Oil Co.—Ind.) Recovery of organic acids with an amine solvent.
2,568,121 (Pure Oil Co.) Preparation of carbon disulfide.
2,568,396 (Union Oil Co.) Process for producing and separating nitrogen oxides.
2,568,426 (Shell Development Co.) Condensation products from poly-ethylenic-unsaturated aldehyde adducts.
2,568,522 (Stanolind Oil and Gas Co.) Separation of mixtures of 1-butanol and methyl n-butyl ketone.
2,568,656 (B. F. Goodrich Co.) Copolymers of an isoolefin and a vulcanizable vinyl cycloolefin.
2,568,692 (Shell Development Co.) Copolymers of vinyl halides and halogenated propenes.
2,568,736 (Visco Products Co.) Alkylated polycyclic sulfonates.
2,568,737 (Visco Products Co.) Reverse detergents.
2,568,747 (Visco Products Co.) Mixed ester amine polybasic acid compositions.
2,568,784 (Victor Chemical Works) Reaction products of olefin oxides and P_2O_5 or P_2S_5 and the method of forming the same.
2,568,876 (Socony-Vacuum Oil Co.) Reaction products of n-acylated polyalkylene-polyamines with alkenyl succinic acid anhydrides.
2,568,950 (Phillips Petroleum Co.) Latices from alkali metal catalyzed polymers.
2,568,902 (Universal Oil Products Co.) Beta thioethyl substituted carbonyl compounds as modifiers in ethylene polymerization.
2,569,132 (Shell Development Co.) Method for production of triketones.
2,569,380 (Standard Oil Development Co.) Production of alcohols from carbon monoxide and hydrogen.
2,569,383 (Standard Oil Development Co.) Polymeric hydrocarbon drying oils.
2,569,425 (Sinclair Refining Co.) Methoxy-ethyl esters of imido acids.

Lubricants

2,566,397-8 (Standard Oil Co.—Ohio) Lubricants and lubricant additives.
2,566,611 (Socony-Vacuum Oil Co.) Mineral oil composition containing an alkyl thienyl ketimine.
2,567,023 (Standard Oil Development Co.) Process of preparing a polyvalent metal soap.
2,566,793 (Shell Development Co.) Lithium grease compositions.
2,568,472 (Gulf Research & Development Co.) Oil compositions containing amine salts of acid compounds of boric acid and hydroxy carboxylic acid.
2,568,583 (Dow Chemical Co.) Method of separating impurities from used lubricating oil.
2,568,965 (Gulf Research & Development Co.) Catalytic isomerization of olefinic hydrocarbons with HF-alumina.
2,569,122 (Shell Development Co.) E. P. lubricant.
2,569,429 (Socony-Vacuum Oil Co.) Synthetic lubricants from F-T olefins.

Catalysts

2,566,521 (Universal Oil Products Co.) Alumina - platinum oxysulfide - halogen catalyst and its preparation.
2,568,209 (Universal Oil Products Co.) Oxygen-BF_3 hydrocarbon complex catalyst.
2,568,352 (Houdry Process Corp.) Preparation of catalyst gel beads by emulsifying.
2,568,403 (Standard Oil Development Co.) Process for subdividing solid particles.
2,569,092 (Union Oil Co.) Phosphoric acid or metal phosphate catalysts on precalcined carriers and their preparation.

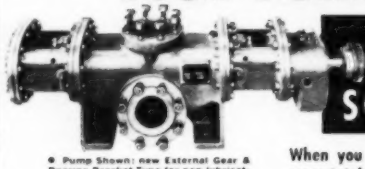
Miscellaneous

2,568,186 (Phillips Petroleum Co.) Apparatus for producing waves in fluid media.

Fuels

2,568,351 (Surface Combustion Corp.) Process for making fuel gas from natural gasoline and straight run gasoline.

DOUBLE THE VALUE OF YOUR PUMP DOLLARS!



Specify Sier-Bath SCREW PUMPS

● Pump Shown: new External Gear & Bearing Bracket Type for non-lubricating fluids, semi-fluids. Capacities 1 - 700 GPM. Discharge 1000 PSI for viscous liquids, 500 PSI for water.

When you choose a Sier-Bath Screw Pump your total investment is about the same—but you get a pump worth *twice as much:*

Investment "A"	TYPICAL CHOICE	*Investment "B"*
Cam, Lobe, Vane or Gear Pump ..... $ 770.00	Sier-Bath Screw Pump	$1570.00
Low Speed Motor (or high speed motor plus reduction gearing) 2580.00	High Speed Motor	1860.00
TOTAL $3350.00	TOTAL	$3430.00

Sier-Bath Screw Pumps are more dependable, need less maintenance, and last longer than the types listed in "A". Because their *axial flow* allows low liquid velocities with higher RPM, they use less expensive (and easier to get) high speed motors. As these motors provide service equal to that of low speed motors—and as Sier-Bath Screw Pumps provide *superior* service—"B" is the right choice.

For further information, see your local Sier-Bath Representative, or write to

Sier-Bath GEAR and PUMP CO., Inc.

9271 HUDSON BLVD., NORTH BERGEN, N. J.

Also Manufacturers of Gearex Pumps, Precision Gears and Flexible Gear Couplings

BUILDING OR MAINTAINING INSTALLATIONS...

Here's THE BEST SUPPLY COMBINATION FOR YOU TO USE!

Top service—top quality!

In the natural gasoline and cycling industries, construction and maintenance engineers alike know that Continental's fast, efficient service . . . coupled with top-quality stocks . . . provide for your special as well as your routine requirements . . . help you avoid costly delays!

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SERVING THE OIL AND GAS INDUSTRIES

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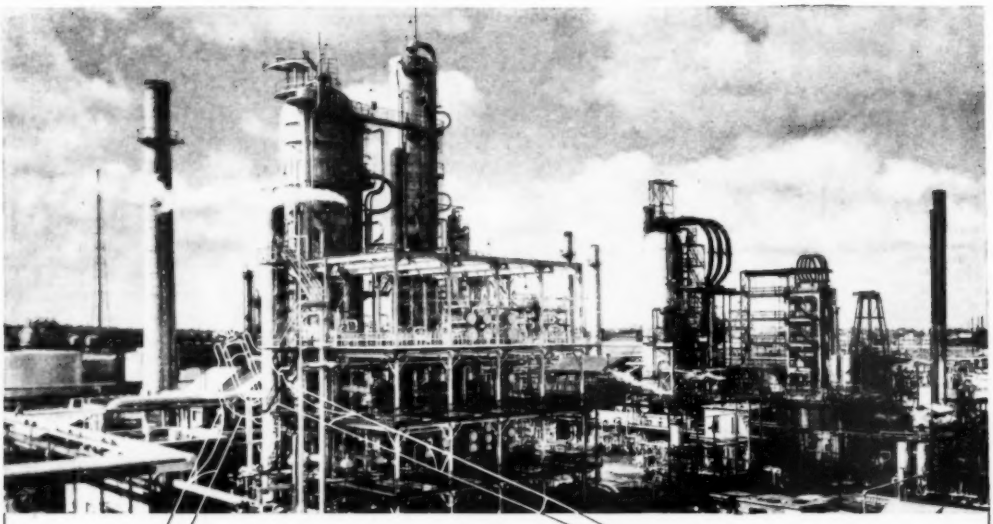
***Export Division:* The Continental Supply Co., Inc., 30 Rockefeller Plaza, New York, N. Y.**
The Continental Supply Company, Limited, 216 Lancaster Building, Calgary, Alberta

Representatives: ARGENTINA • BOLIVIA • BRAZIL • CHILE • COLOMBIA • ENGLAND • ECUADOR • PERU • TRINIDAD • URUGUAY • VENEZUELA



Pritchard Designs for Versatility and Accessibility

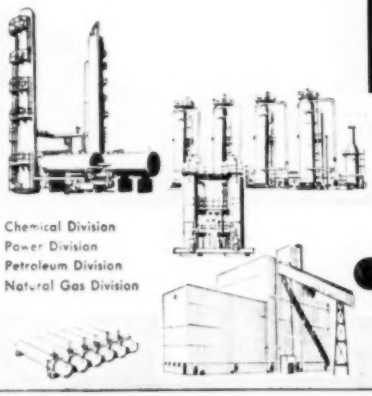
Our Single Responsibility Contract includes:

- Design
- Processing
- Engineering
- Purchasing
- Field Construction
- Guarantees
- Operating Tests
- "Turnkey" Basis

This unit is typical of Pritchard's forward looking ingenuity in Design, Engineering and Construction. Designed to the customer's requirements for replacement of an existing crude unit and for processing six different types of crude oil at a nominal capacity of 22,500 bbls. day, this unit simultaneously produces eight different distillate fractions ranging from light gasoline to cylinder stock!

At the same time particular care was taken to design the unit for maximum accessibility to the heat exchanger equipment, thus facilitating handling and reducing "shut down" time and maintenance costs.

For the most modern advancements in petroleum processing, let Pritchard engineers develop your next project from drawing board to "on stream."



Chemical Division
Power Division
Petroleum Division
Natural Gas Division

NATIONAL CONSTRUCTORS ASSOCIATION MEMBER

J.F. Pritchard & Co.

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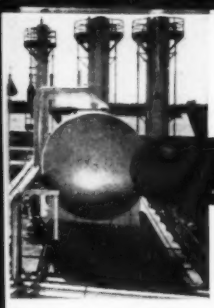
TULSA • ST. LOUIS • Representatives in Principal Cities from Coast to Coast

(To obtain more data on advertised products see page 1292)



EQUIPMENT PATENTS

Brief Reviews of New Inventions in Equipment

Liquid-Liquid Contactor

Improved operation results when countercurrent flow is supplemented with concurrent flow

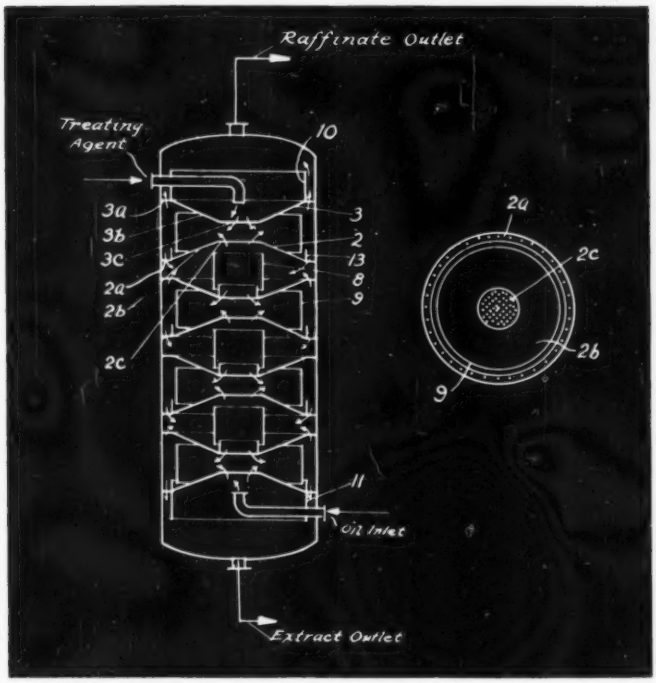


Fig. 1—Two flow relationships improve contacting efficiency in this treating tower design (U. S. 2,569,391)

IN liquid-liquid contacting towers of the type where the liquids are immiscible or of different specific gravities and are in the dispersed phase when brought into contact, efficient operation is hampered because of emulsification or excessive entrainment and recycling.

This can be overcome in a tower so designed that the conventional countercurrent flow is augmented with a simultaneous concurrent flow relationship in a series of zones arranged in groups from top to bottom. The design is shown in the drawings in Fig. 1. The tower may be considered, for an example, as one where acid-treated oil is being neutralized with a caustic soda solution, or one where the neutralized oil is being washed with water. It is also adaptable, of course, to any comparable treating or contacting system.

A vertical series of lateral plate members 2 and 3, inside the tower, are each peripherally joined to the inside wall in fluid-tight connections. Each member 2 is composed of an annular portion 2a, by which it is joined to the wall; a hollow frusto-conical portion 2b, secured at its base edge to the inner edge of 2a; and a closure portion 2c for the smaller open end of the portion 2b. All are concentric with the tower and each other. Each member 3 is composed similarly of comparable portions 3a, 3b, and 3c. Portions 2a, 3a, 2c, and 3c are perforated.

Preferably the total area of these passages in portions 2a and 3a is substantially equal to that in 2c and 3c. But this area relationship may be varied within any one plate, or from plate to plate, to obtain any desired volume flow relationship between the two liquids passing through the tower. By such means, also, the velocity of the liquids may be adjusted to produce any desired degree of fineness in the dispersion resulting from these perforated passages.

By virtue of the arrangement of the two types of plates, 2 and 3, between each pair there is formed a concentric group of mixing, separation, and discharge zones through which the liquids flow radially outward and inward from plate to plate. In each group the volume generally will increase from the mixing zone to the discharge zone.

In addition to the plates, cylindrical baffles are installed as indicated by 8 and 9, which define the boundary between the separation and discharge zones. These baffles avoid liquid entrainment by impeding straight-through flow and providing some degree of hold-up time. Further impedance to flow is provided by weirs 10 and 11.

U.S. 2,569,391, issued September 25, 1951, to Reid F. Stearns, assignor to Standard Oil Development Co.

Patents Issued in September

The following classified listing covers patents issued during the month of September believed to be of value or interest to petroleum processing or handling operations:

Processing, general

2,566,310 (Hydrocarbon Research, Inc.)—Tray type heat exchanger for recovering the cold content of outgoing oxygen and nitrogen products in the production of oxygen by the liquefaction and rectification of air.

2,567,765 (Peter J. W. Debye)—Apparatus and method for effecting thermal diffusion.

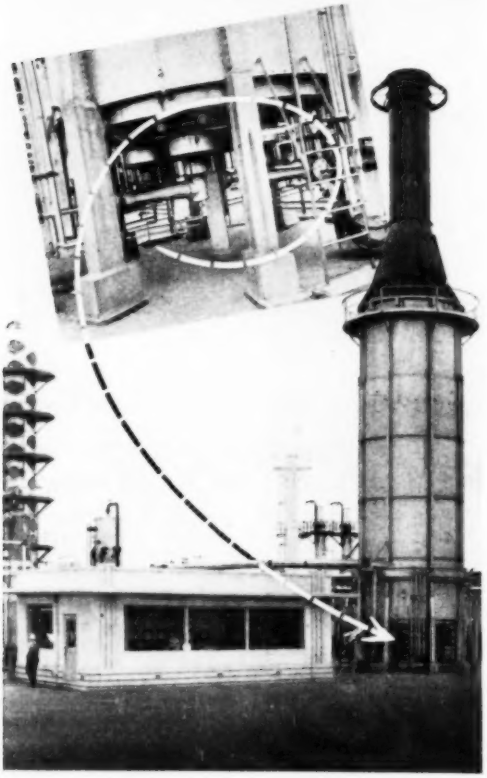
2,568,186 (Phillips Petroleum Co.)—Apparatus for producing waves of supersonic frequencies in gas or liquid media.

2,569,391 (Standard Oil Development Co.)—Liquid-liquid contacting tower.

Instrumentation

2,566,307 (Illinois Testing Laboratories, Inc.)—Dew point measuring apparatus and method.

EQUIPPED WITH...



NATIONAL AIROIL TANDEM COMBUSTION UNITS

A large Petro-Chem petroleum heater, in a modern Texas refinery, equipped with National Airoil combination gas and oil Tandem Block Combustion Units, for firing upward. This Installation is one of many throughout the U. S. and other countries so equipped with our exclusive Tandem Units. Latest literature gladly sent upon request on your business letterhead.

CHEMICAL-PETROLEUM DIVISION

NATIONAL AIROIL BURNER COMPANY, INC.

1297 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.

Southwestern Division: 2512 South Boulevard, Houston 6, Tex.

Equipment Patents

2,566,369 (Henry M. Putman)—Pressure gauge.
2,566,680 (Elmer D. Smyser)—Positive displacement type flow indicator.
2,567,253 (Standard Oil Co.—Indiana)—Pressure gauge, particularly for low gas pressure measurement.
2,567,532 (Electric & Musical Industries Ltd., Hayes, England)—Electrical analogue device.
2,567,823 (Evershed & Vignoles Ltd., London, England)—Liquid level indicator.
2,568,238 (American Machine & Metals, Inc.)—Fluid separating diaphragm in fitting for pressure gauges.
2,568,309 (Richard A. Werts)—Automatic bleeder for water and oil separation for oil storage tanks, scrubbers and the like.
2,568,379 (Union Oil Co. of California)—Level control for granular solids, particularly for selective adsorption processes.
2,568,566 (William M. Mercer)—Liquid level control mechanism.
2,568,574 (Charles Alfred West)—Sensitivity improver for temperature controllers.
2,568,689 (Socony-Vacuum Oil Co., Inc.)—Electronic ammeter.
2,569,032 (Consolidated Engrg. Corp.)—Constant pressure inlet for mass spectrometers.
2,569,127 (Shell Development Co.)—Refractive index measurement of fluids.

Valves & Fittings

2,566,343 (Standard Oil Co.—Indiana)—Positive shutoff device.
2,566,772-3-4-5 (Herbert C. Otis)—Safety control valve.
2,567,032 (Crane Co.)—Rotary plug valve.
2,567,243 (Joseph B. Smith)—Sleeve coupling for pipes.
2,568,026 (Gulf Research & Development Co.)—Relief and control valve.
2,568,414 (Ira A. Russ)—Pipe joint.
2,569,316 (Daniel L. Jerman)—Differential pressure closed safety valve.
2,569,412 (Crane Co.)—Gate valve.

Tools

2,566,661 (Ingersoll-Rand Co.)—Power-operated impact wrench.
2,567,303 (Walter Statkus)—Pipe handling apparatus for welding.
2,567,833 (C. E. Warren and E. A. Morris)—Pipe cutter.
2,568,314 (Walter H. Bell)—Equipment for cleaning oil storage tanks.
2,568,694 (Chicago Specialty Mfg. Co., Inc.)—Pipe bender.

Tanks & Vessels

2,567,920 (Chicago Bridge & Iron Co.)—Floating roof.
2,568,111 (The Pure Oil Co.)—Corrosion-resistant storage tank.
2,568,529 (John H. Wiggins)—Side wall seal for floating tank roofs.

Pumps & Compressors

2,567,479 (Phillips Petroleum Co.)—Polish rod stuffing box.
2,567,699 (Barnes Mfg. Co.)—Gear type pump for liquids.
2,568,356 (Tony M. Moulden)—Variable displacement pump.
2,568,357 (Tony M. Moulden)—Variable displacement radial piston pump.

Miscellaneous

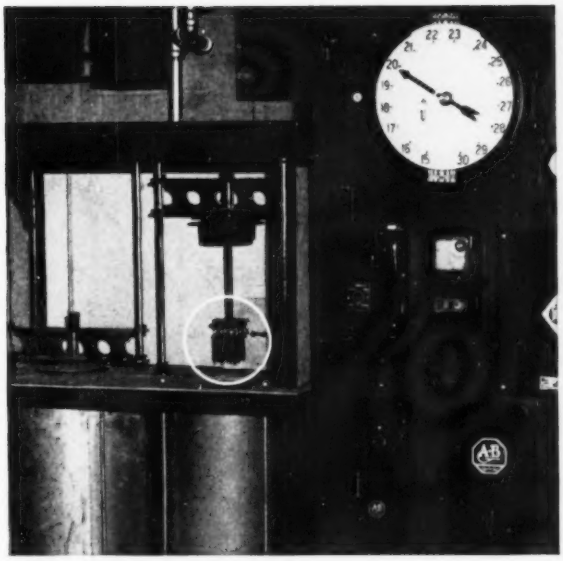
2,566,430 (Precision Scientific Co.)—Support for laboratory filtering apparatus or the like.
2,567,207 (Houdry Process Corp.)—Means of maintaining catalyst activity in hydrocarbon conversion systems.
2,567,809 (Garlock Packing Co.)—Adjustable rotary shaft seal.
2,568,240 (The Marley Co.)—Spray nozzle.

How to Obtain Patents

Readers may obtain copies of any U. S. patent from the Patent Office at 25 cents each. Order by patent number direct from the Commissioner of Patents, Washington 25, D. C.

(To obtain more data on advertised products see page 1292)

SCALING RESISTANCE EVALUATED AT HIGH TEMPERATURES



High-Temperature Corrosion Often Is the Main Factor in Metal Failure

Learning why metals fail at high temperatures – determining the actual cause of damage and suggesting as a remedy a more suitable material–these are the jobs of INCO High-Temperature Engineers, who are getting information on such problems for the use of industry.

INCO laboratories in Bayonne, N. J., and Huntington, West Va., have useful data on the properties of metals at elevated temperatures. This information comes from tests made to determine the creep strength, stress-rupture, and other properties of materials at temperatures in some cases up to 2100°F.

Industrial experiences at high temperatures indicate that it is unwise to predict high-temperature performance on the basis of room-temperature properties or short-time high-temperature tests. Other methods have been developed that provide more accurate measures for judging materials.

The machine pictured above was especially designed by INCO Engineers for determining the effect of cyclic heating and cooling on sheet metals while exposed to oxidizing conditions. INCO High-Temperature research likewise covers damage by other corrosive atmospheres. Through work with this and other types of equipment INCO Engineers study the reasons for failure of alloys at high temperatures.

Due to the volume changes accompanying its formation, an oxide film formed at high temperatures on the surface of a metal or alloy is usually under compressive stress. Contraction stresses developed when the underlying metal is cooled further aggravate this situation – and with many alloys may cause rupturing of the normally protective oxide.

Among the factors which influence the resistance to oxidation, the physical characteristics of the formed scale are of importance. The sketches show how these characteristics may cause the breakdown of the scale and thus increase the rate of oxidation.

Blistering may occur in oxide layers having good elasticity but poor adherence to the metal surface.

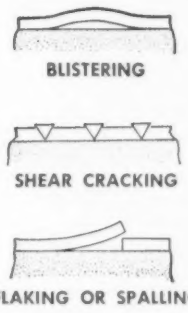
Shear cracking on the other hand will be found in oxides that are adherent but relatively brittle.

Flaking or spalling results when the oxide is both brittle and non-adherent.

As the scale peels away from the metal, it exposes a fresh area to further attack. A point of importance is that the loss of the oxide causes a progressive loss in metal section–useful load-carrying metal.

In high-temperature applications employing sheet or strip, the necessity of obtaining maximum resistance to this form of destruction by selection of a suitable heat-resisting alloy is of greatest importance.

Oxide Scale Breakdown by:



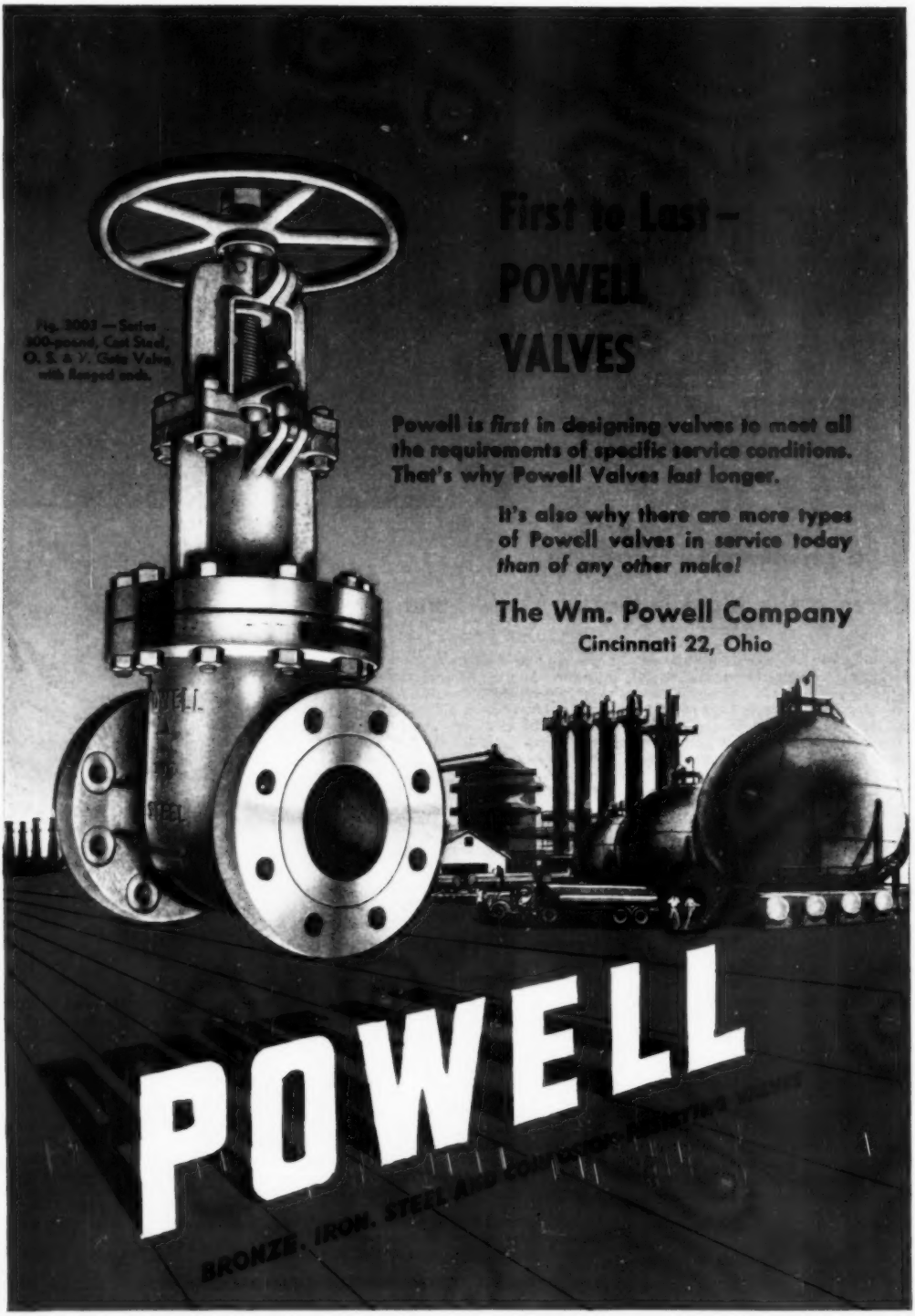
If high-temperature alloy performance is a problem to you, whether in present activities or in new projects, INCO High-Temperature Engineers will do their best to be of help to you. Let them send you the *High-Temperature Work Sheet* . . . it is a big aid in explaining your situation fully. Then see if INCO Engineers cannot help solve your difficulty.

EMBLEM OF SERVICE

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street, New York 5, N. Y.

(To obtain more data on advertised products see page 1292)


First to Last—
POWELL
VALVES
Fig. 3003 — Series 300-pound, Cast Steel, O. S. & Y. Gate Valve with flanged ends.
Powell is first in designing valves to meet all the requirements of specific service conditions. That's why Powell Valves last longer.
It's also why there are more types of Powell valves in service today than of any other make!
The Wm. Powell Company
Cincinnati 22, Ohio
POWELL
BRONZE, IRON, STEEL AND CORROSION-RESISTING ALLOYS

NEWS OF SUPPLIERS

Manufacturers
Distributors
Engineering Firms

Research Firm Adds to Petrochemical Activity

NATIONAL RESEARCH CORP.'s new equipment division building, soon to be built in Boston suburb

Dr. Steadman

Mr. Vaughan

CONTINUED expansion of activities, at least partially in the field of petrochemicals, has resulted in National Research Corp.'s announcing the appointment of two new executives and plans to build additional plant facilities.

Thomas R. Steadman has joined the petrochemicals research dept. to take over the supervision of the organic chemistry phases of a research program undertaken jointly by National Research, The Electric Bond and Share Co., and United Gas Corp. in the development of new chemicals from natural gas. James L. Vaughan has been appointed director of the process engineering department.

A new building will be erected in Newton, Mass., to augment the facilities of the company's general administrative and sales offices and its laboratory at 70 Memorial Drive, Cambridge, Mass. The new building, expected to be ready for occupancy early in February, 1952, will be used by the equipment division. It will house a machine shop, welding shop, electronic assembly facilities, and engineering and drafting rooms.

Dr. Steadman, who comes to National Research after ten years in organic chemistry with B. F. Goodrich at Brecksville, Ohio, received his B.S. in Chemistry from Rensselaer Polytechnic Institute in 1937, and his Ph. D. in organic chemistry from Harvard in 1941.

Mr. Vaughan joined the company following four years as a design and development engineer with Rohm & Haas Co. He has a bachelor's and a master's in chemical engineering from M.I.T. From 1937 to 1943 he was a chemical engineer with Standard Oil Co. (N. J.). Subsequently he was chief technologist for Shell Chemical Corp. at Dominguez and at Martinez plants in California. Before joining Rohm & Haas, Mr. Vaughan was assistant professor of chemical engineering at Rhode Island State College.

Rockwell VP Goes to NPA

Mr. Kerr

A. J. Kerr, vice president of meter and valve sales for Rockwell Mfg. Co., Pittsburgh, has been appointed Chief of the Valves and Fittings Branch, General Components Division of the National Production Authority. He will work under the direction of Eugene S. McCarthy, director of the division, and will headquarter in Washington. Charles W. Burrage, whom Kerr succeeds in the NPA post, is returning to his job at The Lunkenheimer Co.

A mechanical engineering graduate of Carnegie Tech and formerly a director of the ASME, Mr. Kerr has been associated with Rockwell for 25 years. He had been district sales manager in Tulsa until 1944, when he came to Pittsburgh as general sales manager.

Enters Fiber Glass Field

Pittsburgh Plate Glass Co. will enter the fiber glass production field in the near future, according to an announcement by executive vice president Richard B. Tucker. Formation of a separate development and production unit to be known as the Fiber Glass Division is now in process. Two types of fiber glass, strand fiber and superfine fiber, will be manufactured under licensing agreement with Owens-Corning Fiberglas Corp.

The new division will be headed by J. Hervey Sherts as general manager. Associated with Pittsburgh Plate since 1928, Mr. Sherts has been director of the product development dept. since 1939.

Fluor Builds Addition

Fluor Corp. has completed another engineering building at its home office location in Los Angeles, marking a speed-up of its expansion program to meet emergency needs. Built at a cost of $400,000, the new two-story, pre-cast re-inforced concrete building of 27,000 sq. ft. floor space contains 50 offices on the first floor for engineering, process, and construction personnel. On the second floor are three drafting rooms for 85 draftsmen and office space for project engineers. An assembly room seating 75 to 100 persons is provided in the basement.

Clark Promotes Three

A. G. Van Campen, most recently district sales manager of Clark Bros. Co., Inc., Chicago territory, has been named district sales manager of the Tulsa Mid-Continent territory. He has been with the company for 15 years in technical and sales capacities, having spent four years in the New York office prior to his post in Chicago.

Succeeding Mr. Van Campen in Chicago is Robert C. Smith, who spent a number of years on the Pa-

cific Coast with a major oil company as a project engineer on refinery construction. M. G. Daniels, with Clark for several years, has been appointed industrial sales engineer in the Chicago office, which is located at 122 So. Michigan Ave.

Norton Forms Export Firm

The formation of a new company, Norton Behr-Manning Overseas, Inc., has been announced by Norton Co. and its subsidiary, Behr-Manning Corp. New firm will handle all of the export business and direct the subsidiary plant operations of these two corporations throughout the world. Headquarters will be in Worcester, Mass., with branches in New Rochelle, and New York, N. Y.

Previously, the Behr-Manning foreign operations were directed by Behr-Manning Overseas Inc. of New Rochelle, and those of Norton were handled by its foreign division at Worcester.

Wolverine Names Two in Sales

E. J. Campbell has been appointed mid-western district sales manager of the Wolverine Tube Division of Calumet & Hecla Consolidated Copper Co. Affiliated with the company since 1943, Mr. Campbell was responsible for establishing the Grand Rapids office in 1945 and development of sales activities in western and southwestern Michigan. He had been promoted to assistant mid-western district sales manager in 1948.

John M. Dumser, who joined Wolverine last month, has been named assistant to the general sales manager. He will work under George D. Potter, general sales manager, and will headquarter at the general offices in Detroit, Mich.

Oronite Promotes Elwell in East

Dr. Elwell

W. E. Elwell has been named manager of Eastern product development of the Oronite Chemical Co., a wholly-owned subsidiary of Standard Oil of California. His headquarters will be at 30 Rockefeller Plaza, New York City.

Formerly supervisor of chemical products for California Research Corp., Dr. Elwell has worked for California Standard and subsidiaries for the past 13 years. He was graduated from the College of Puget Sound with a bachelor's degree in 1933 and received his Ph. D. at Washington University in 1938.

Personnel Changes

Cooper-Bessemer Corp. — Edward D. Van Fossen to regional field office in Seattle to provide further engineering service in the northwest.

American Cyanamid Co. — V. R. Farlow to sales supervisor of the petroleum chemicals dept. from technical representative in Chicago office. G. L. Glespen to technical supervisor of the dept. from supervisor of catalyst products.

Solvay Sales Division—E. J. Seener to branch manager in St. Louis, at 3615 Olive Street.

Chiksan Co.—C. E. Thomas to sales staff, assigned to eastern offices, 155 Washington St., Newark, N. J., from General Cable Corp.

American Meter Co.—Earl B. Cutter to assistant to the vice president in charge of sales, from a sales post in the midwest. Joseph L. Kiraly to assistant to the vice president in

CHIKSAN MARINE & BARGE HOSE

LIGHT WEIGHT • EASY TO HANDLE

With the CHIKSAN aluminum Marine & Barge Hose, dock-to-vessel connections can be made by one man in just a few minutes. When not in service, the hose easily and quickly folds into a compact unit, without requiring disconnection from the Dock Riser. The same hose can be used for both suction and discharge.

MANY EXCLUSIVE ADVANTAGES

The CHIKSAN Hose, when used as shown, saves time, labor and expense, as well as dock space, and permits free movement of other equipment.

CHIKSAN Marine & Barge Hose, being made of metal, is not affected by severe climatic conditions or by petroleum products which may cause other hose to deteriorate rapidly. For the same reason, this all-metal hose is not subject to kinking, crushing or cutting—thus outlasting other hose.

CHIKSAN Marine & Barge Hose can be supplied in any required length and size, with end connections as specified, in either aluminum or steel, for above-surface or underwater service.

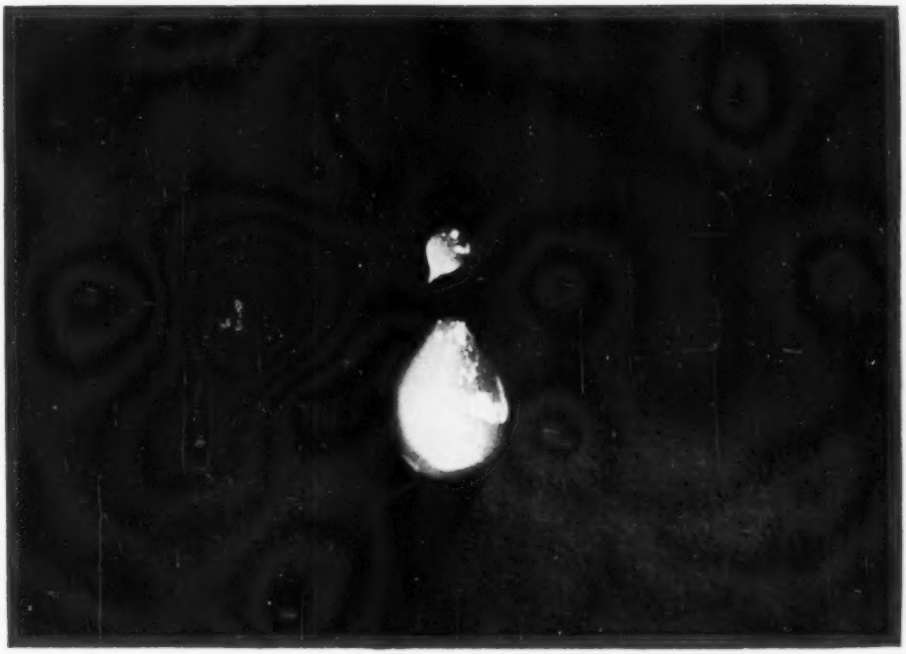
CHIKSAN TRADE MARK REG.

CHIKSAN COMPANY
AND SUBSIDIARY COMPANIES
Chicago 3, Ill. BREA, CALIFORNIA Newark 2, N. J.
WELL EQUIPMENT MFG. CORP. HOUSTON 1, TEXAS
CHIKSAN EXPORT CO. BREA, CALIFORNIA NEWARK 2, N. J.

WRITE FOR COMPLETE CHIKSAN CATALOG

REPRESENTATIVES IN PRINCIPAL CITIES
SOLD BY LEADING SUPPLY STORES EVERYWHERE

(To obtain more data on advertised products see page 1292)



What Price . . . A Drop of Acid?

The price of a drop of acid is mighty small as long as you keep it in a carboy. But let it out — give it half a chance to get to your equipment — and it really can get expensive.

In oil refineries, particularly, chemical attack is a major problem — one that can cost plenty in "down time" and equipment replacement — one that can cause no end of headaches. But you can stop your troubles before they start — keep the cost of chemical fumes and spillage 'way down — with TYGON "Series TP" PAINT. Virtually all acids, alkalies, oils, and waters roll off a TYGON painted surface "like water off a duck's back".

Here's just some refining equipment that can benefit from the protection of TYGON PAINT: Sour crude tanks, acid sludge tanks, "run-down" tanks, refrigeration units, alkali tanks, pumps, piping, fume ducts and hoods, and fire-fighting equipment. TYGON also does an excellent job of protecting structural steel, walls, and ceilings from chemical attack.

And, here are some of the refinery chemicals that are "stopped" by TYGON: Caustic soda, sulfuric acid, ammonia, hydrochloric acid, magnesium chloride, phosphoric acid, salt, hydrogen sulfide, and sulfur dioxide.

TYGON PAINT is available in a wide range of colors. It requires no more surface preparation than that of good commercial practice. It is easily applied by brushing or spraying. Its dry film is smooth and practically impermeable. It's tough, flexible, non-aging, non-flammable and easy to clean.

Make your first line of defense against chemical attack a good, thoroughly protective coating! Make it TYGON PAINT!

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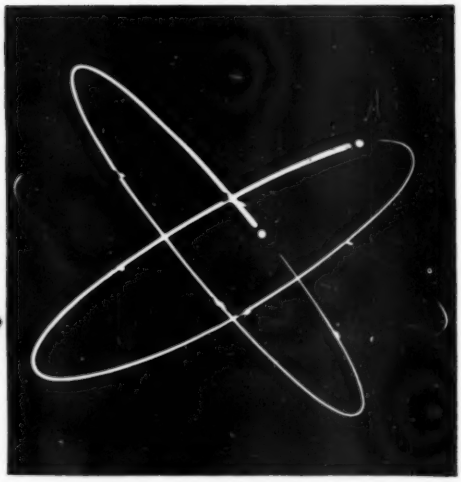
TYGON
the corrosion-resistant plastic
PAINT

 (To obtain more data on advertised products see page 1292)

first

all-electronic control



of pressure

temperature

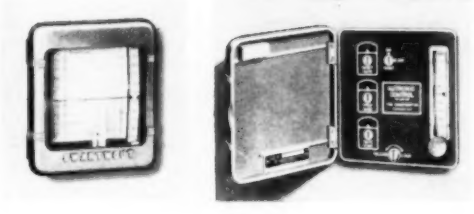
flow

and level . . .

The new Swartwout Autronic Control System is the first miniature all-electronic control system for process and power instrumentation. Completely revolutionary in conception, it is the ultimate in centralized control no matter how stringent your requirements for accuracy, speed, reliability and compactness.

Because transmission of information throughout the Autronic Control System is by electrical means *only*, there is no transmission lag; control of final element is accurate, positive and *instantaneous*. Right from the primary measuring element to the final element there is no mechanical motion whatsoever . . . no slide wires to initiate control action . . . no booster mechanisms or other delicate equipment to overcome distance effects . . . no trouble caused by air leaks or frozen air lines.

Call in our engineering representative to explain how the Swartwout Autronic Control System can bring new accuracy and speed to *your* process instrumentation and control. Or write *today* for literature on the new Swartwout Autronic Control System.



Swartwout *Autronic* CONTROL SYSTEM

THE SWARTWOUT COMPANY • 18511 EUCLID AVENUE • CLEVELAND 12, OHIO

charge of production, from Stevenson, Jordan and Harrison, New York management consultants.

American District Steam Co., Inc.—Arthur H. Sy to vice president in charge of sales, from sales manager-ship.

General Controls Co.—Felix Weingerter to district manager of New York branch office. Eldon Burnett to manager of the newly-opened branch at Omaha, Neb.

Master Tank and Welding—Tom Haley to sales manager, with headquarters in Dallas. C. A. McGee to office manager.

Dowell, Inc.—Claude H. Groom to assistant sales development manager, from development engineer in that division. Other recent promotions: James Reed to development engineer in the service and product development department, and Roy Bostick to sales development engineer in the sales department, both at Tulsa. Six employes at Edmonton, Canada, promoted: William Stemp, area development engineer; Spence Lawrence, office manager; William Wedderburn and Lewis McCabe, service supervisors; and A. E. Thorson and Wallace Thorvaldson, sales engineers.

Branches, Distributors

Dowel Inc., has opened a new operating station in Beaumont, Texas, located at Fourth and Terrill Sts. Manager will be J. C. Ivy, formerly a service engineer at Alice, Tex. Other personnel will include R. S. Harris, J. A. Buvens, and W. G. Frederick.

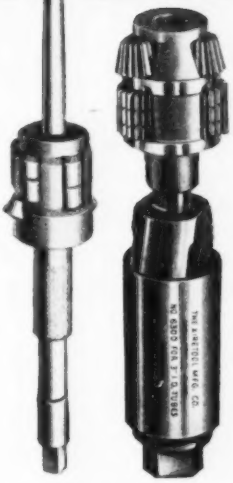
Bigelow-Liptak Corp., Detroit, has appointed Otto von Perbrandt as Ohio representative. His office is at 305 Schwartz Bldg., 906 Main St., Cincinnati.

Chiksan Co. has appointed Hydrobel, S.A., Liege, Belgium, as export sales representative for Belgium, Grand Duchy of Luxembourg, and the Belgian Congo.

Arcos Corp., Philadelphia, has appointed exclusive distributors for the St. Louis, Mo., and Des Moines, Iowa, territories: Clements Welding & Machinery Co., 700 Hawk Ave., St. Louis 10, will service that city and that part of Missouri and southern Illinois east of Springfield and Sedalia: The R. & R. Welding Supply Co., 315 12th St., Des Moines, will cover central Iowa, including Cedar Rapids, Mason City, Waterloo, and Fort Dodge.

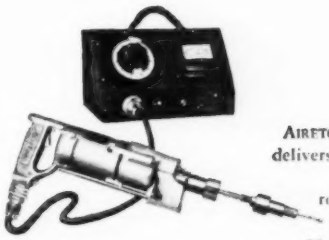
Metals Disintegrating Co., Inc. has appointed the Truesdale Co., Boston, as distributors in the New England area.

AIRETOOL tube cleaners and expanders have long been the leaders in their respective fields. Maintenance crews prefer them because they are fast, easy to use and don't "conk out" just when they are needed most. In design, in performance, in results, you can't beat AIRETOOL refinery tools. They're TOPS.



●

OUTROLLS ordinary tube rolling methods two to one



AIRETOOL's amazing Tube Rolling Control delivers a new high in accuracy and speed to every tough job when it comes to rolling heat exchanger and condenser tubes. A powerful motor drives an AIRETOOL ball-bearing type expander which is mechanically controlled to stop at the precise second when perfect expansion has been accomplished. Full details will be sent by return mail. Write The AIRETOOL Manufacturing Company, 336 S. Center St., Springfield, Ohio.

BRANCH OFFICES:
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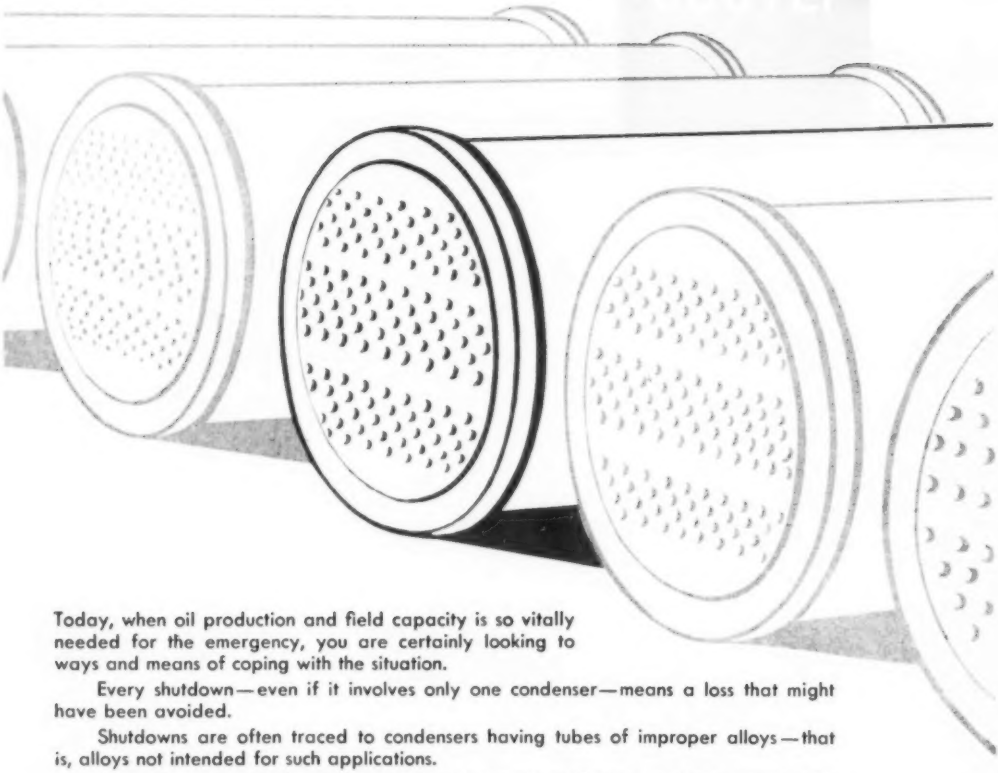
AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

There's an AIRETOOL Tube Cleaner and Tube Expander for every Type of Tubular Construction

(To obtain more data on advertised products see page 1292)

Losing efficiency of even one condenser is COSTLY



Today, when oil production and field capacity is so vitally needed for the emergency, you are certainly looking to ways and means of coping with the situation.

Every shutdown—even if it involves only one condenser—means a loss that might have been avoided.

Shutdowns are often traced to condensers having tubes of improper alloys—that is, alloys not intended for such applications.

Wolverine can provide condenser tubes in a variety of alloys and can counsel with you as to the best one to use under your prevailing conditions.

Let us help you in the selection of proper alloys to do the most efficient job for you.

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Chemistry Has December Spotlight, AIChE Honors Houdry's Kirkbride

THE program of the 44th annual meeting of the American Institute of Chemical Engineers, Dec. 2-5 in Atlantic City indicates several noteworthy features for petroleum processing men. Included are 1) a panel discussion on the future of unit operations in chemical engineering, 2) a two-session symposium of 16 papers on heat transfer, 3) symposiums on chemical engineering fundamentals and waste disposal, and 4) a number of general sessions including papers on the Arosorb process, catalysis, radioactivity, etc.

C. G. Kirkbride, vice president and director of Houdry Process Corp., is the 1951 winner of the Professional Progress Award in Chemical Engineering, sponsored by the Celanese Corp. of America and administered by the AIChE. The award, carrying with it $1000 in cash, has been given to Mr. Kirkbride, who is in charge of research and development for Houdry, for:

"His many contributions and gifted leadership in chemical engineering education and practice, for his scientific developments underlying petroleum technology, and for his tireless and unselfish service to the profession."

In his award lecture, Mr. Kirkbride will discuss "Taxation, Socialism, and Collapse." Before becoming associated with Houdry, Mr. Kirkbride was with Standard Oil Co. of Indiana; Pan American Refining Corp., as assistant director of research; Magnolia Petroleum Co., as chief of chemical engineering development; and Texas A & M College, as professor of chemical engineering.

The author of the book, "Chemical Engineering Fundamentals," published in 1947, he has written numerous articles on heat transfer, multicomponent fractionation and phase equilibria, and holds patents on desalting crude oil and high pressure absorption of hydrocarbons.

"Whither Chemical Engineering Science?" is the title given an informal panel which begins the meeting on Sunday afternoon, December 2. A group of five, with Professor George Granger Brown of the University of Michigan as moderator, will discuss changing concepts in modern processing which seem to be leading to the demise of the classical idea of unit operations. The panel group includes J. C. Elgin, Princeton; K. H. Hachmuth, Phillips Petroleum Corp.; R. L. Pigford, University of Delaware; J. H. Rushton, Illinois Institute of Technology; and T. K. Sherwood, M.I.T.

The heat transfer symposium will employ a unique approach. Set up by Donald L. Katz and Alan S. Foust of the University of Michigan, it will comprise 16 papers scheduled for morning and afternoon sessions on Dec. 5. The papers will not be presented separately, because of time limitations. Instead, they will be presented in condensed form by the session chairmen and then discussed. To facilitate discussion, all papers are being made available in preprint form. The single volume of preprints may be obtained now at $2.50 each by ordering direct from the Office of the Executive Secretary, American Institute of Chemical Engineers, 120 East 41 St., New York 17, N. Y. Copies will also be on sale at the registration desk during the Atlantic City meeting.

Among papers of interest in the waste disposal session is "Advances in Petroleum Refinery Waste Treatment" by Roy F. Weston, Atlantic Refining Co. The paper on the Arosorb process, scheduled for a general technical session, will be given by James I. Harper, John Lee Olsen, and Frank R. Shuman, Sun Oil Co. Another paper of interest is "Production of Methane from Coal—An Economic Study," by L. W. Alberts, J. S. Bardin, D. W. Beery, H. R. Jones, and E. J. Vidt, Blaw-Knox Construction Co.

The annual Awards Banquet will be held Tuesday, Dec. 4, at 7:00 p.m. in the Chalfonte Hotel. Principal speaker is the Hon. Thomas E. Murray of the U. S. Atomic Energy Commission.

All sessions of the meeting will be held in the Chalfonte and Haddon Hall hotels. Registration will take place in the English Lounge of the Haddon Hall, beginning Dec. 2 and 1:00 p.m.

23rd Chemical Exposition

THE 23rd Exposition of Chemical Industries, to be held in New York's Grand Central Palace, Nov. 26 to Dec. 1, is expected to be the largest show in 20 years. According to preliminary estimates, over 400 companies are among the list of exhibitors.

Among the many new items to be shown in this year's exposition on all four floors of the Palace are miniature instruments for the modern graphic control panels, corrosion-resistant materials of construction, refractories, heat transfer units with high efficiencies, new types of filter designs, chemical analyzing devices, proportioning pumps, high vacuum equipment, ultrasonic and hypersonic generators for processing equipment, and many others.

The exposition will open Monday, November 26 at 2:00 p.m., and daily thereafter at 11:00 a.m. Closing hours are 10:00 p.m. on Monday, Tuesday, Thursday, and Friday; and 6:00 p.m. on Wednesday and Saturday. Admission will be by invitation and registration only, the general public being excluded. A. E. Weidlein, president of Mellon Institute, is chairman of the Advisory Committee.

An interesting sidelight on the Chemical Show is that the first one, held back in 1915, was the result of an idea and some hard-plugging by a young chemist with Standard Oil Co. of New York, Charles F. Roth. As a volunteer librarian at the New York Chemists' Club, Roth decided an exposition would be an ideal way of obtaining information on equipment as compared to digging in books. Since that time—and still active today — Roth is associated with the New York "Chem Show."

OIL MAN'S CALENDAR

NOVEMBER

20. Natural Gasoline Assn. of America, Panhandle-Plains Regional meeting, Herring Hotel, Amarillo, Texas.

25-30. American Society of Mechanical Engineers, annual meeting, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J.

26-Dec. 1, 23rd Exposition of Chemical Industries, Grand Central Palace, New York City.

29-30. Ninth Annual Pittsburgh Diffraction Conference, Mellon Institute, Pittsburgh, Penna.

DECEMBER

2-5, American Institute of Chemical Engineers, annual meeting, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J.

3-4, Chemical Specialties Manufacturers' Assn., 38th annual meeting, Hotel Mayflower, Washington, D. C.

JANUARY, 1952

14-17, Plant Maintenance Show, Convention Hall, Philadelphia, Penna.

21-25, American Institute of Electrical Engineers, winter general meeting, Hotel Statler, New York City.

MARCH

3-7, American Society for Testing Materials, spring meeting and committee week, Hotel Statler, Cleveland, Ohio.

11-14, National Assn. of Corrosion Engineers, 8th annual conference and exhibition, Municipal Pier, Galvez & Buccaneer Hotels, Galveston, Texas.

16-19, American Society of Chemical Engineers, regional meeting, Biltmore Hotel, Atlanta, Ga.

31-April 2, Western Petroleum Refiners Assn., annual meeting, The Plaza Hotel, San Antonio, Texas.

APRIL

30-May 2, Natural Gasoline Assn. of America, 31st annual meeting, Rice Hotel, Houston, Texas.

MAY

6-9, Scientific Apparatus Makers Assn., annual meeting, Edgewater Beach Hotel, Chicago, Ill.

11-14, American Society of Chemical Engineers, regional meeting, French Lick Springs Hotel, French Lick, Ind.

12-15, American Petroleum Institute Refining Division, 17th annual mid-year meeting, St. Francis Hotel, San Francisco, Calif.

22-24, American Society for Quality Control, Sixth annual convention, Syracuse, N. Y.

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REFINING TRENDS

Current Data on Crude Runs, Product Supply and Demand

Refiners Now Within Sight of Stocks Level Requirements Set for Dec. 31

THERE are now available to refiners two sets of estimates of what their stocks of major refined products should be on Dec. 31 to meet domestic demand in the early part of 1952 and also to continue to contribute to easing the world petroleum shortage caused by the closing of the Abadan refinery in Iran. Barring extremely unseasonal weather here, or some other emergency abroad, these estimated requirements likely will be achieved.

PAD's Deputy Administrator Bruce K. Brown early in October told the Louisiana Department of Conservation the following levels for refinery stocks on Dec. 31 were desirable in view of anticipated requirements: Gasoline 123 (million barrels); kerosine 24; distillate 84; residual fuels 48; total 279,000,000 bbls. These estimates were predicated on running 6,675,000 b/d avg. crude to stills during the 4th quarter of '51, and on supplying 190,000 b/d avg. to foreign agencies to assist in making up the shortage caused by closing the Abadan refinery.

With this Dec. 31st stock level achieved, Mr. Brown estimated that about 100,000 b/d of refined products could be withdrawn from refinery stocks in the first quarter of 1952 to aid in mitigating world shortages without endangering domestic supplies.

Later in October, the Economics Committee of the Independent Petroleum Assn. announced its estimates of product stock levels for Dec. 31 as follows: Gasoline 121,500,000 bbls.; kerosine 24,600,000; distillates 84,300,000; residuals 44,900,000 bbls. The total of the IPAA estimates is only a little under Deputy Brown's estimated requirements.

Actual refinery stocks on Oct. 27, 1951, were as follows: Gasoline 111,120,000 bbls. (API data); kerosine 33,500,000; distillate fuels 102,100,000; residual fuels 49,170,000. The total of nearly 296,000,000 bbls. is nearly 30,000,000 bbls. higher than stocks on Oct. 31, 1950, and by far the largest inventories refiners have ever had.

In 1950, gasoline stocks built up by nearly 12,000,000 bbls. in November and December. If this is done this year, total gasoline stocks on Dec. 31 will reach the estimate of the PAD authority. In the same two months in 1950, heating oil stocks (kerosine and distillates) were reduced by 23,000,000 bbls. This amount of reduction from the total on Oct. 27th this year of 135,600,000 bbls. would bring the year-end figure to 112,600,000 bbls., as compared with the Brown estimate of requirements of 108,000,000 bbls. Residual fuel oils were reduced by around 3,500,000 in the last two months of 1950.

Crude Runs: Indicated crude runs to stills in October dropped to under 6,500,000 b/d avg., the decrease being mostly in the volume of imported crude.

Motor Fuel: Indicated refinery production of gasoline in October was 10.5% above that of October, 1950.

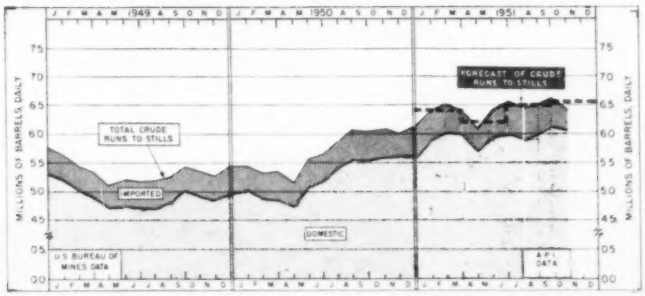
Heating Oils: Indicated refinery output of kerosine and distillates in October was 8.5% higher than in October, 1950, while for 9 months there was an increase of 22% in the supply of these products. Current indicated demand for kerosine is stronger than the average for 9 months. The buildup in refinery stocks of heating oils this October was considerably less than last October. Table 1 shows the distribution of heating oils by refining districts as of Sept. 29, 1951, and Sept. 30, 1950 (API data).

Table 1—Distribution of Heating Oil Stocks (Kerosine and Distillation) by Refinery Districts, Sept. 30, 1950-Sept. 29, 1951, API Date.

(1000 bbls.)

	Total Heating Oils			
	Sept. 30 1950	Sept. 29 1951	Change	% Chg.
East of California				
East Coast	33,180	45,537	+ 12,057	36
Gulf Coast	22,964	24,297	+ 1,333	5
Appalachian	1,631	2,493	+ 862	53
Ind.-Ill.-Ky.	18,589	28,708	+ 10,119	53
Okla.-Kans.-Mo.	9,405	13,228	+ 3,823	41
Inland Tex., Neb., Ark.	2,998	4,000	+ 1,002	33
Rocky Mountain	2,581	2,660	+ 79	3
Total East of California	91,678	120,923	+ 29,275	32
California	12,905	9,903	- 3,002	23
Total U. S.	104,583	130,856	+ 26,273	25

Fig. 1—Less Imported Crude Run in October



Crude Runs to Stills

Daily Average (1000 bbls.)

	Domestic	Foreign	TOTAL
Oct. '51 API*	6,037	436	6,473
Oct. '50 BM	5,592	485	6,077
Change	+ 445	- 49	+ 396
% Change	7.9	10.1	6.5

* Through Oct. 27

	Total (1000 bbls.) (Bureau of Mines Data)		
9 Mo. '51*	1,626,817	140,420	1,767,237
9 Mo. '50	1,402,927	131,460	1,533,487
Change	+ 224,790	+ 8,960	+ 233,750
% Change	↑16.1	6.8	15.2

*September from API data.

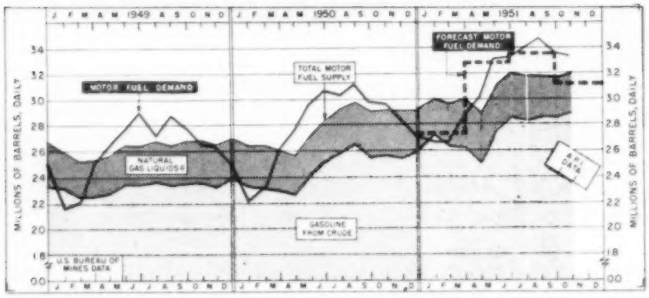
BM Forecast of Crude Runs to Stills, 1951
(Revised Sept. 25; 1000 b/d avg. by Quarters)
1st Q., 6,492; 2nd Q., 6,708; 3d Q., 6,538; 4th Q., 6,669

Yields on Crude Runs to Stills

	Gasoline %	Kerosine %	Dist. Fuels %	Resid. Fuels %
Oct. '51 API*	43.8	5.5	29.2	18.8
Sept. '51 API	43.4	5.5	29.8	18.7
Aug. '51 BM	43.3	5.2	28.9	18.7
Oct. '50 BM	41.9	5.4	29.8	20.5

* Through Oct. 27

Fig. 2—Gasoline Output Holds at High Level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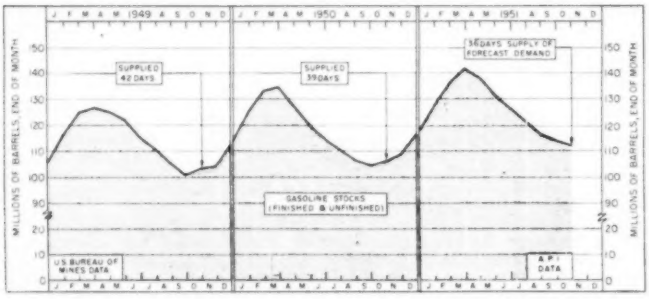
MOTOR FUEL DEMAND
TOTAL MOTOR FUEL SUPPLY
FORECAST MOTOR FUEL DEMAND
NATURAL GAS LIQUIDS*
GASOLINE FROM CRUDE
A.P.I. DATA
U.S. BUREAU OF MINES DATA
MILLIONS OF BARRELS, DAILY

*Natural Gas Liquids include gasoline blended at refineries, and used direct as motor fuel

Fig. 3—Small Drop in "Gas" Stocks in October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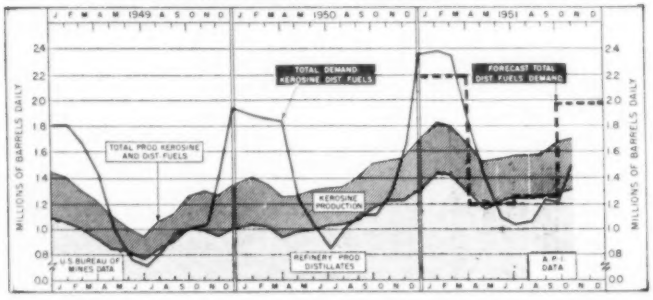
J F M A M 1951 A S O N D
SUPPLIED 42 DAYS
SUPPLIED 39 DAYS
36 DAYS SUPPLY OF FORECAST DEMAND
GASOLINE STOCKS (FINISHED & UNFINISHED)
U.S. BUREAU OF MINES DATA
A.P.I. DATA
MILLIONS OF BARRELS, END OF MONTH

Fig. 4—Sharp Pickup In Heating Oil Demand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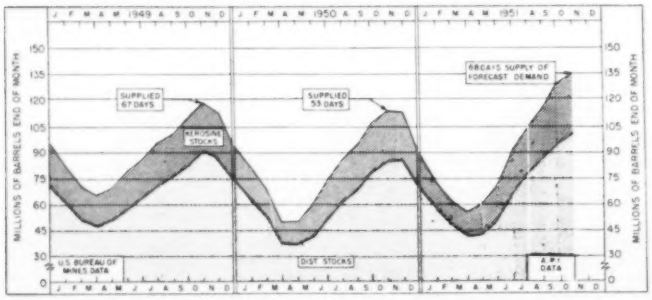
TOTAL DEMAND KEROSINE DIST. FUELS
FORECAST TOTAL DIST. FUELS DEMAND
TOTAL PROD KEROSINE AND DIST FUELS
KEROSINE PRODUCTION
REFINERY PROD DISTILLATES
U.S. BUREAU OF MINES DATA
A.P.I. DATA
MILLIONS OF BARRELS DAILY

Fig. 5—Heating Oil Stocks Top 135,000,000 Bbls.


J F M A M 1949 A S O N D
J F M A M 1950 A S O N D
J F M A M 1951 A S O N D
SUPPLIED 67 DAYS
SUPPLIED 53 DAYS
48 DAYS SUPPLY OF FORECAST DEMAND
KEROSINE STOCKS
DIST STOCKS
U.S. BUREAU OF MINES DATA
A.P.I. DATA
MILLIONS OF BARRELS END OF MONTH

Motor Fuel Supply

Daily Average (1000 bbls.)

	Gasoline from Crude	Natural Gasoline Blended Used Direct	TOTAL
Oct. '51 API*	2,845	350	3,195
Oct. '50 BM	2,575	353	2,930
Change	+270	—3	+265
% Change	10.5	09	9.0

* Through Oct. 27

Total (1000 bbls.) (Bureau of Mines Data)

9 Mo. '51*	748,928	95,580	844,538
9 Mo. '50	666,602	88,662	755,264
Change	+82,356	+6,918	+89,274
% Change	12.3	7.8	11.8

*September from API data.

Motor Fuel Demand

Including Exports
Daily Average (1000 bbls.)

Oct. '51 API*	3,240
Oct. '50 BM	2,948
Change	+292
% Change	9.9

* Through Oct. 27

Total (1000 bbls.) (Bureau of Mines Data)

9 Mo. '51*	847,215
9 Mo. '50	759,212
Change	88,023
% Change	11.6

* September from API data

BM Forecast of Motor Fuel Demand, 1951
(Revised Sept. 25, 1000 bbl. avg. by Quarters)
1st Q., 2,752; 2nd Q., 3,270; 3d Q., 3,548; 4th Q., 3,109

Gasoline Stocks

Finished and unfinished, end of month (1000 bbls.)

Oct. '51 API*	111,120
Sept. '51 API	112,405
Aug. '51 BM	114,446
Oct. '50 BM	105,764

* On Oct. 27

Heating Oils Production

(Kerosine and Distillates)
Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
Oct. '51 API*	461	1,219	1,680
Oct. '50 BM	331	1,217	1,548
Change	+29	+103	+132
% Change	8.8	8.5	8.6

* Through Oct. 27

Total (1000 bbls.) (Bureau of Mines Data)

9 Mo. '51*	100,186	350,707	450,893
9 Mo. '50	86,732	283,031	369,763
Change	+13,454	+67,676	+81,130
% Change	15.5	23.9	22.2

*September from API data

Heating Oils Demand

Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
Oct. '51 API*	370	1,130	1,500
Oct. '50 BM	311	989	1,300
Change	+59	+141	+200
% Change	18.9	14.3	15.4

* Through Oct. 27

Total (1000 bbls.) (Bureau of Mines Data)

9 Mo. '51*	86,115	328,610	414,762
9 Mo. '50	80,188	281,808	361,996
Change	+5,927	+44,811	+50,766
% Change	7.4	15.8	13.9

* September from API data

BM Forecast of Heating Oil Demand
(Kerosine and Distillates)
(Revised Sept. 25, 1000 bbl. avg. by Quarters)
1st Q., 2,398; 2nd Q., 1,102; 3d Q., 1,214; 4th Q., 1,978

Heating Oil Stocks

(1000 bbls. end of month)

	Kerosine	Dist. Fuels	TOTAL
Oct. '51 API*	33,541	102,106	135,647
Sept. '51 API	33,820	96,905	130,725
Aug. '51 BM	30,231	87,442	117,673
Oct. '50 BM	28,292	85,643	113,935

* On Oct. 27

Fig. 6—Refinery Output of Residuals Drops

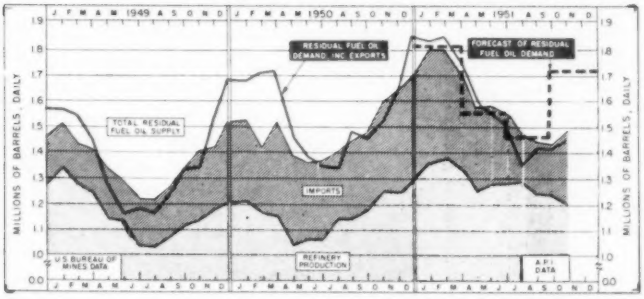
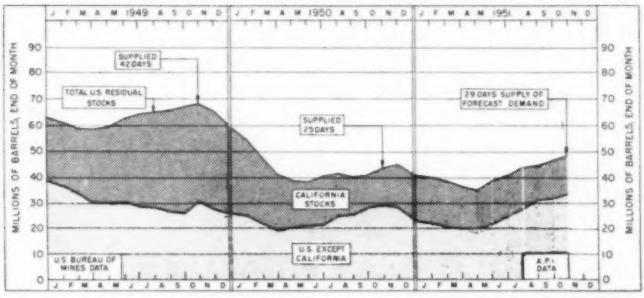


Fig. 7—"Resid" Stocks Hold Upward Trend



Residual Fuels Production

Daily Average (1000 bbls.)

	Refinery Output	Imports	TOTAL
Oct. '51 API*	1,200	295	1,495
Oct. '50 BM	1,250	343	1,593
Change	−50	−48	−98
% Change	4.0	14.0	6.2

* Through Oct. 27

Total (1000 bbls.)
(Bureau of Mines Data)

9 Mo. '51*	351,579	85,663	437,042
9 Mo. '50	308,781	84,087	392,868
Change	+42,798	+1,576	+44,174
% Change	13.8	1.9	12.6

* September from API data

Residuals Fuels Demand

Daily Average (1000 bbls.)

Oct. '51 API*	1,450
Oct. '50 BM	1,526
Change	−76
% Change	4.9

* Through Oct. 27

Total Demand (1000 bbls.)

9 Mo. '51*	433,842
9 Mo. '50	414,999
Change	+18,842
% Change	4.5

* September from API data

BM Forecast of Residual Fuels Demand

(Revised Sept. 28; 1000 b/d avg. by Quarters) 1st Q., 1,825; 2nd Q., 1,544; 3d Q., 1,449; 4th Q., 1,706

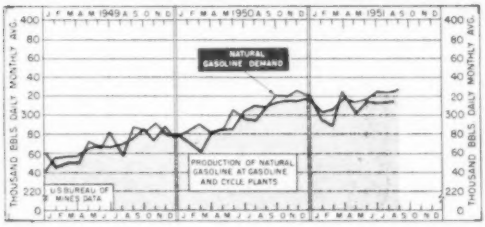
Residual Fuel Stocks

1000 bbls. end of month

	U.S. Except California	Total U.S.
Oct. '51 API*	33,491	40,168
Sept. '51 API	32,115	47,903
Aug. '51 BM	31,413	47,241
Oct. '50 BM	28,845	44,586

* On Oct. 27

Fig. 8—Production and Demand of Natural Gas Liquids



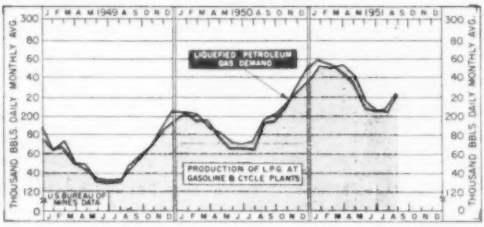
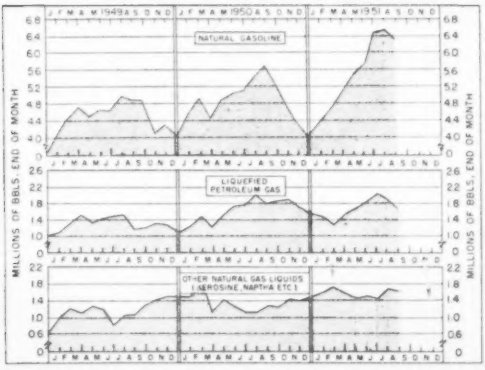


Fig. 9—Stocks of Natural Gas Liquids



Natural Gas Liquids Statistics

(Source: U. S. Bureau of Mines Report on Natural Gasoline and Cycle Plant Operations)

	Production (1000 gal./day avg.) Natural Gasoline	LPG**	TOTAL	Demand* (1000 gal./day avg.) Natural Gasoline	LPG	TOTAL
August '51	324	223	547	317	225	542
August '50	309	189	498	302	193	495
Change	+15	+34	+49	+15	+32	+47
% Change	4.8	18.0	9.4	4.9	16.6	9.5

	Total Production (1000 gal.)			Total Demand (1000 gal.)		
8 Mos. '51	76,995	56,294	133,289	75,103	55,678	130,781
8 Mos. '50	71,150	44,993	116,143	69,976	44,260	114,236
Change	+5,845	+11,301	+17,146	+5,129	+11,418	+16,547
% Change	8.2	25.1	14.7	7.3	25.8	14.5

Stocks, End of Month (1000 gal.)

	By Type of Product: Natural Gasoline	LPG	Oth'r Products†	By Location: Ref'neries	Gasoline Plants	TOTAL
August '51	6,584	1,798	1,701	3,464	6,419	9,883
July '51	6,573	1,919	1,708	3,840	6,360	10,200
August '50	5,663	1,818	1,216	2,744	5,953	8,697

* Demand, including exports but not transfers, is supplied from receipts from outside sources, as well as current production and stock changes at gasoline plants. Outside receipts in August totaled 149,000 bbls.

** Does not include LPG produced at refineries which in August totaled 2,716,000 bbls.

† Includes naphtha, kerosine, specialty and other products.

ADVERTISERS' INDEX

FOR INFORMATION ON ANY PRODUCT OR SERVICE ADVERTISED IN THIS ISSUE SEE INSTRUCTIONS BELOW

Each advertiser listed in this index has been assigned a code letter for use by the reader in securing additional information about advertised products or services which interest him. This code letter appears in parentheses to the left of the advertiser's name.

Circle the code letter on the "Advertised Product Inquiry" card (on the page opposite) which corresponds to that assigned the advertiser about whose product you want further information.

Fill in your name, title, company and mailing address and mail the card . . . no postage is required.

The Petroleum Processing Reader Service Department will give your inquiries prompt and efficient handling.

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(A3) AMERICAN CYANAMID CO. 1186
(A4) AMPCO METAL, INC. 1222, 1223
(A5) ANDERSON CO., THE V. D. 1205
(A6) ANNIN CO., THE 1206
(A7) BADGER & SONS CO., E. B. 1226, 1227
(A8) BADGER MFG. CO. 1193
(A9) BAKER & ADAMSON PRODUCTS, GENERAL CHEMICAL DIV., ALLIED CHEMICAL & DYE CORP. Inside Back Cover
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(B2) BLACK, SIVALLS & BRYSON, INC. 1224
(B3) BROWN FINTUBE CO., THE 1204
(B4) BYRON JACKSON CO. 1263
(B5) CHICAGO BRIDGE & IRON CO. 1210
(B6) CHIKSAN CO. 1282
(B7) CHILDERS MFG. CO. 1194
(B8) CONTINENTAL SUPPLY CO. Facing 1276
(B9) CRANE CO., THE 1212
(C1) DIAMOND POWER SPECIALTY CORP. 1217
(C2) DIETERT CO., HARRY W. 1302
(C3) DU PONT DE NEMOURS & CO., INC., E. I. Facing 1228, 1229
(C4) DU PONT DE NEMOURS & CO., INC., E. I. 1274
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(D6) HARDESTY CO., W. C. 1200
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(F2) NORDSTROM VALVE DIV. 1184, 1185
(F3) NORTON CO., THE Facing 1196, 1197
(F4) OAKITE PRODUCTS, INC. 1298
(F5) OHIO STEEL FOUNDRY CO. 1200
(F6) OHIO STEEL FOUNDRY CO. 1296
(F7) OIL WELL SUPPLY CO., UNITED STATES STEEL CORP. 1268
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(G2) PETRO-CHEM DEVELOPMENT CO., INC. 1208, 1209
(G3) PETROLEUM PROCESSING 1211
(G4) PETROLEUM RECTIFYING CO. 1181
(G5) PITTSBURGH LECTRODRYER CORP. 1197
(G6) POWELL CO., WM. 1280
(G7) PRITCHARD & CO., J. F. 1270
(G8) PRITCHARD & CO., J. F. Facing 1277
(G9) PRITCHARD & CO., J. F. 1301
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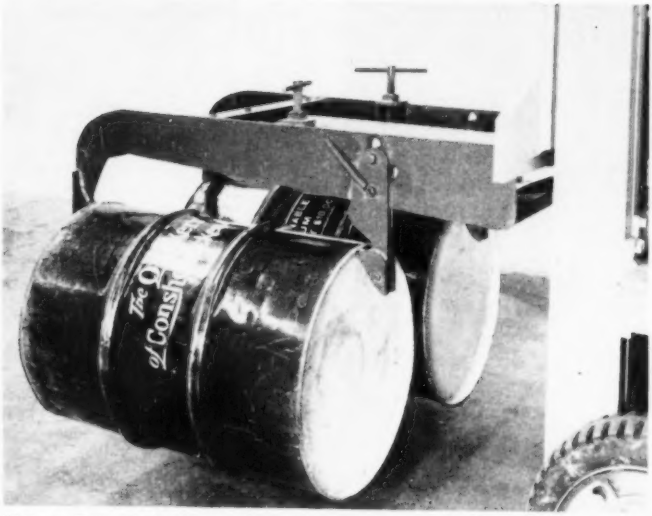
(H6) SWARTWOUT CO., THE 1284
(H7) TAYLOR FORGE & PIPE WORKS 1305
(H8) TAYLOR INSTRUMENT CO. 1202, 1203
(H9) TRANE CO., THE 1265
(I1) U. S. STONEWARE CO. 1283
(I2) UNIVERSAL OIL PRODUCTS CO. 1198, 1199
(I3) VOGT MACHINE CO., HENRY 1201
(I4) WIEDEKE CO., THE GUSTAV 1273
(I5) WOLVERINE TUBE DIV. 1286
(I6) WORTHINGTON PUMP & MACHINERY CORP. 1228
(I7) WYATT METAL & BOILER WORKS Outside Back Cover
(I8) YARNALL-WARING CO. 1297

WHAT'S NEW!

Equipment
Materials
Processes
Literature

Reviewed by WILLIAM C. UHL, Equipment Editor

Device Carries Drums Horizontally



Yale & Towne's horizontal drum handler can be quickly attached to forks of any standard lift truck.

A new horizontal drum-handling device can be attached to any industrial fork lift truck without removing the forks or making any hydraulic or mechanical connections. Completely automatic, the device is a self-contained unit that fits over the forks and is secured with two screw type clamps. One or two standard drums can be picked up by lowering the unit over them while the truck is slowly backing away. The rear clamps are spring-loaded and snap under the lip of the drum. As lifting occurs, gravity action locks the clamps in place. There is no load on the springs at any time. Depositing the drums is equally simple. The drums are lowered, the truck is moved forward (stretching the springs on the rear clamps), and as soon as the front clamps are free, the channels on the truck are tilted back. Then the truck is backed away to free the rear clamps. The attachment weighs 270 lbs. and permits the drums handled to be filled with any common material. Drums can be stacked to any height within the lifting range of the truck. Yale & Towne Mfg. Co., 11000 Roosevelt Blvd., Philadelphia, Penna.

Circle No. 1 on Reply Card

For More Information

Use one of the attached reply cards to request additional details or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the rest of the card and drop it in the mail. No postage required.

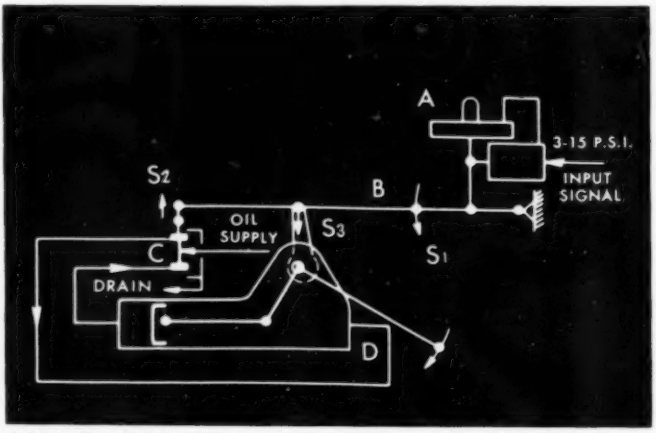
Precise Control in Water Bath Holds Temperature to ±0.005 C.

High precision in the control of water bath temperatures is said to be obtainable with the new Fisher "Isotemp" Bath — ±0.005° C. over its entire range of about −5 to +107° C. Actual tests, the makers state, have produced variations as small as 0.002° over a long period of time. An electronic circuit is employed to control a 400 and an 800-watt heater. The heating elements, stirrer, and controls are contained in a central column with all connections made through the bottom of the 15 x 15-in. Pyrex glass bath, thus providing an unobstructed top surface for inserting samples. Stirring is accomplished with an 1150 rpm. motor and propellers, which keeps the entire 10 gal. water (or light mineral oil, if desired) in constant motion. The bath is illuminated from the bottom by fluorescent lamps. Samples, inserted through any of the eight openings in the rotatable cover, may be turned to the front of the bath for observation. An accessory cooling coil may be obtained to provide temperatures below that of the room. Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Penna.

Circle No. 2 on Reply Card

Remote Positioner Is Operated Hydraulically, Regulated by Air

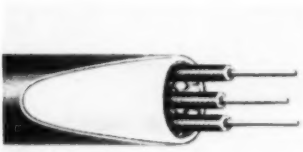
An air-controlled, hydraulically-operated crank cylinder, one in a series of remote positioning units, responds to a 3-15 psi. pneumatic input signal. It can be used in combination with pneumatic controllers or loading devices to control dampers, butterfly valves, plug type valves, or any other lever operated device. It permits exact positioning in direct ratio with the applied air signal by transforming the signal pressure, through a hydraulic relay, into a greatly amplified operating torque. As illustrated in the drawing, the diaphragm motor



Askania Regulator's remote positioner, operated hydraulically and controlled pneumatically

with pneumatic positioner *A* produces a stroke S_1 which is directly proportional to the input air signal. This stroke, by means of linkage *B*, displaces by an amount S_2 the piston of pilot valve *C* which directs oil flow to either end of the cylinder *D*. The rotation of the cylinder crank shaft restores the pilot valve piston to its neutral position by an eccentric motion S_3 in opposition to displacement S_2. Thus, for every position of the diaphragm motor stem there is a definite, corresponding position of the crank arm. For a cylinder with a $3\frac{1}{2}$-in. bore, stalling torque of the crank arm is 3750 in.-lbs., and speed at zero load is 90° in 5 sec. Askania Regulator Co., 240 East Ontario St., Chicago 11, Ill.

Circle No. **3** *on Reply Card*



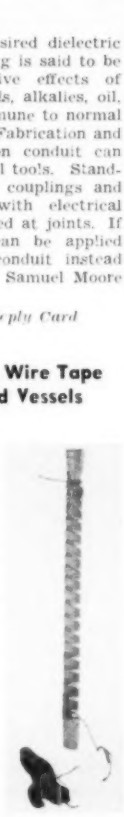
Electrical Tubing Is Coated with Plastic for Corrosion Resistance

A new plastic armored electrical metallic tubing has been developed for use where corrosive atmospheres necessitate frequent replacement of conventional electrical conduit. It is made by the patented extrusion process for using "Dekoron," producing a 0.020-in. coating of vinyl or polyethylene plastic over standard galvanized tubing. The composition and the thickness of the coating can be varied to give any desired dielectric properties. The coating is said to be impervious to corrosive effects of moisture, salt air, acids, alkalies, oil, and grease, and is immune to normal temperature changes. Fabrication and installation of Dekoron conduit can be done without special tools. Standard compression type couplings and connectors wrapped with electrical insulating tape are used at joints. If desired, the plastic can be applied over standard rigid conduit instead of galvanized tubing. Samuel Moore & Co., Mantua, Ohio.

Circle No. **4** *on Reply Card*

Flexible Resistance Wire Tape Will Fit Odd-shaped Vessels

A new flexible heating tape has been developed for small glass vessels of standard or odd shape—such as distilling or fractionating columns. Designed to operate at so-called "black heat," the tape is said to produce high wattages without excessive heating of the wire. Being well below the glow point, this eliminates the danger of fire in the presence of flammable materials. This has been possible because of the construction of the heating tape, which utilizes a large amount of wire in a comparatively small area. The tape consists of resistance wire covered with a double insulating sheath of white braided glass fiber yarn, complete with lead wires for connection directly to 110 volt current. It can also be made to operate on 220 volt current. Constant temperatures may be maintained by a voltage regulator. The tape comes in three standard lengths —2, 4, and 6 ft. Wattage for these three is 115, 190, and 275, respectively. Standard width is $\frac{1}{2}$ in., but other widths from $\frac{1}{4}$ to 2 in. may be had. Scientific Glass Apparatus Co., Inc., Bloomfield, N. J.



Circle No. **5** *on Reply Card*

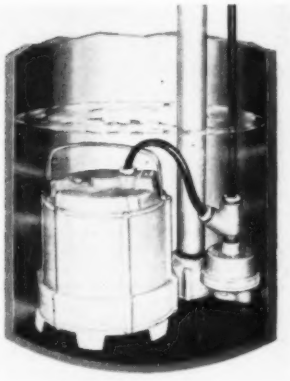
"Blind" Controller Has Single Adjustment for Two Responses

The "Transet Bi-Act" is a new, non-indicating, force-balance controller with a single knob adjustment for two control responses. Designed for applications where it is desired to transmit the measured variable to a remote location, the controller is said to be particularly adaptable to flow, liquid level, or pressure applications requiring fast reset rates and broad throttling bands, or where derivative action is not essential. The one knob adjusts both proportional and automatic reset responses so that processes can be brought to a stable condition easily. Controller action can be changed without disturbing piping connections. An optional, plug-in type, leakless manifold provides simple connection or removal of the controller. The unit can be either panel or field mounted. It measures $7\frac{1}{2}$ in. overall length, and has a range of adjustment of 1-200% throttling range and automatic reset of 0-100 repeats per minute. Taylor Instrument Cos., 95 Ames St., Rochester 1, N. Y.

Circle No. **6** *on Reply Card*

Submersible Sump Pump Needs No Float, Uses Pressure Switch

A patented automatic liquid level control switch eliminates the need for a float in a new submersible utility, or sump pump. The switch has no moving parts exposed to water. It turns on the pump automatically when pressure created by water rising in the switch skirt moves a diaphragm. Water, silt, or other debris cannot foul the switch. It is possible to pump a sump dry to within $\frac{5}{8}$ in. of the bottom. Since the entire pump is submersible, the entire portable unit can be installed in a sump in a few minutes rather than requiring the drive motor on top of the sump to be supported by a permanent mounting. The motor is hermetically sealed in oil, and requires no lubrication. Pump weighs 50 lbs., and measures $9\frac{1}{2}$ in. high with a maximum diameter of 13 in. It is of all bronze construction. With a capacity of 55 gpm., it is driven by a 1/3 hp. motor. Known as Model P-109MA, it is available in both manual and automatic styles if desired, provided with a thru-cord switch to permit manual starting at any water depth. After manual starting, the unit can be set to operate automatically. Kenco, Inc., 1125 North Ridge Rd., Lorain, Ohio.



Circle No. **7** *on Reply Card*

Corrosives-Handling Pump Built For Safe Service on Carboys

The removal of corrosive liquids from carboys and similar containers has long been a problem in laboratories, pilot plants, etc. Disadvantages in most available devices has led many volume users to purchase corrosives in more costly small unit bottles, simply because the material is easier to handle that way. A new "Carboypump" operating on the positive displacement principle and employing Pyrex and Teflon in its construction, is said to offer a practical solution to the problem. Designed by Dow Chemical Co., with revisions by J. A. Glover of Sinclair Research Laboratories, the pump is shown in the accompanying photograph. Fabricated from heavy Pyrex tubing, the pump has check valves of Pyrex and pumping rings of Teflon. Standard ball joint connects the pouring spout to the pump body and is held in place with standard ball joint clamp. The pumping ring can be readily replaced in case of wear. Laboratory Industries, Inc., 4710 West North Ave., Chicago 39, Ill.

Circle No. **8** *on Reply Card*

DID YOU MISS THESE?

The following items, reviewed originally in the September "What's New!" have aroused considerable interest among readers. They are repeated here briefly as a service to those who might have missed them. For details or copies of literature, use the regular reply card in this issue.

Gas Snubbers Solve a High Pressure Metering Problem

Snubbers to control gas surge have solved a metering problem recently in lines to input wells used for pressure maintenance purposes. They did away with erratic behavior of the meters, balanced up total amount of gas going to input wells with amount flowing from an absorber, and for the first time, provided the company with a quick and accurate means of discovering gas leaks, thus saving large quantities of gas. The snubbers were placed between the compressors and the "master" meters on the input well lines, eliminating bad pulsations on the master meters. Following completion of the installation, all meters in the system could be balanced. When they are not in balance, a leak is indicated. The snubbers are not tuned for suppression of surge at any specific frequencies, and since standing pattern along pipes is not fixed, they may be located in any convenient place ahead of the meters. Burgess-Manning Co., 1203 Dragon St., Dallas, Texas.

Circle No. **9** *on Reply Card*

Cathodic Protection Installed In Open Type Condenser Boxes

Open type condensers at Standard Oil Co.'s (Ohio) refinery are protected against electrolytic corrosion by cathodic protection equipment. Operated on D-C from selenium rectifiers, the equipment consists of special electrodes immersed in the water from the top of the boxes, preventing corrosion on the coils and box surfaces. The installation takes into consideration all factors, such as water and metal chemical characteristics, dissolved oxygen content of the water, temperatures, protective coatings already in, coil spacing, etc. The Harco Corp., 16963 Broadway, Cleveland, Ohio.

Circle No. **10** *on Reply Card*

Copper and Alloys vs Corrosion

Corrosion Resistance of Copper and Copper Alloys, Anaconda Publication B-36; 24 pages explaining the chemical and physical nature of corrosive attack in its various forms on these metals; including a tabulation indicating relative resistance of principal copper and copper base alloys in contact with 183 corroding agents. American Brass Co., Waterbury 20, Conn.

Circle No. **11** *on Reply Card*

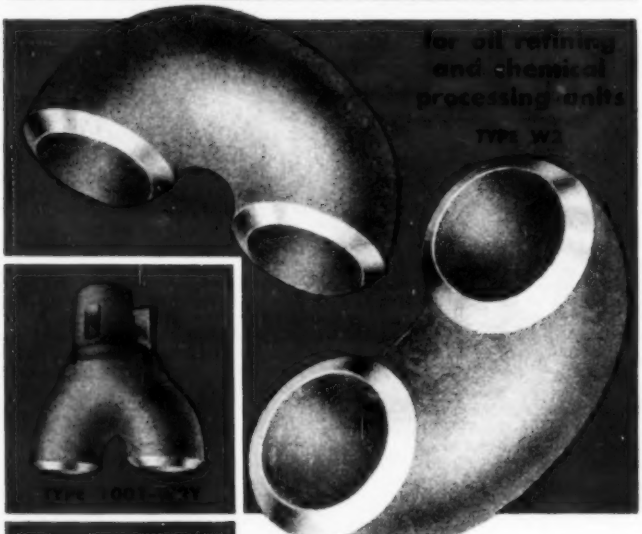
Small Controlled Volume Pumps

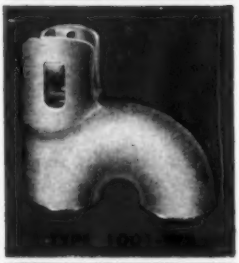
Milton Roy Controlled Volume Pumps, Bulletin No. 151; 24 pages of technical details on reciprocating, positive displacement pumps of the controlled volume type, with capacities ranging from 50 gpm. down to 3 ml./hr.; including four pages of charts showing relative corrosion resistance of materials of construction to 170 chemical compounds. Milton Roy Co., 1300 East Mermaid Lane, Philadelphia 18, Penna.

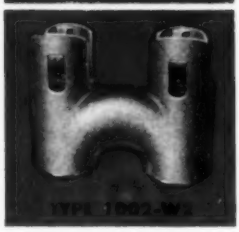
Circle No. **12** *on Reply Card*

OHIO

WELDING-TYPE FITTINGS







CAST WELDABLES GIVE YOU:

1. Lower cost
2. Longer life
3. Shorter centers
4. Heavier walls

They can be furnished for all tube and pipe sizes, and I.D. and wall thickness; on close center dimensions; from any type of cast material.

IMPORTANT. In your specifications send us: I.D. of tube; O.D. of tube; operating conditions; inlet and outlet pressures and temperatures; center dimensions.

Three of the welding fittings shown here have cleanout or inspection openings equipped with Ohio Type 1000 closures. Other closures are available.

The Ohio Steel Foundry Company

LIMA, OHIO

PLANTS AT LIMA AND SPRINGFIELD, OHIO

What's New!

Automatic Temperature Scanner Prints 270 Points at Fast Rate

A new electronic scanning system has been developed to monitor continuously and automatically up to 270 separate temperature readings at scanning rates of one point per second (when average difference between successive points is 25% of scale). It can be set to record only those temperatures deviating beyond a pre-set limit, if desired. The printing system in the recorder can be arranged so that 1) temperature is recorded only when set point is exceeded, 2) temperatures are recorded continuously, 3) no temperatures recorded but scanning continues, or 4) only manually selected points are recorded.

An independent set point is provided for each group of nine temperature points constituting a bank; provides selective repetition or omission of pairs of banks, selective measurement and recording of points, and indicator lamps to identify point of measurement. Synchronism between scanning and printing, if lost during manual manipulation, is automatically restored. Alarm circuits can be reset manually. Scanning is uninterrupted by printing or alarm functions.

Essentially, the system comprises the following assemblies: one 12-record, 4½-sec., strip chart "Electronik" recorder with synchro-balance printing; one rectifier unit for operating stepping switches and control circuits; one control unit for scanning; required number of switch units, each housing specified number of stepping switch assemblies and thermocouple connections, thermocouples, wiring, etc.

In general, operation is based on the action of the synchro-balance printing mechanism in the recorder. As this mechanism switches from point to point, a snap switch is actuated, and a D-C pulse is applied to the stepping switches. This connects the appropriate thermocouple into the circuit, simultaneously energizing the corresponding point lamp and bank lamp.

A print holdout mechanism incorporated in the recorder permits printing only on deviation from set points. The recorder is also equipped with 1) independent chart drive so chart movement occurs only during printing sequences, providing chart economy; 2) separate operation of printing and standardizing mechanism by standard synchronous motion; and 3) pulsing circuit for synchronizing stepping switches with the printing mechanism.

Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Wayne & Windrim Aves., Philadelphia 44, Penna.

Circle No. **13** *on Reply Card*

Trade Literature

U. S. Gasolines Since 1937

Motor Gasolines in the United States since 1937; 28-page booklet comprising an article by H. J. Gibson, T. H. Risk, and J. B. Macauley, covering developments in laboratory and road knock testing methods, refining processes, and postwar fuels and problems, during the period of time indicated. Ethyl Corp., 100 Park Ave., New York 17, N. Y.

Circle No. **14** *on Reply Card*

Chemical Spectroscopy

Burrell Announcer, No. 51 10 44, includes a five-page article on the historical background of chemical analysis by means of the spectroscope. Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Penna.

Circle No. **15** *on Reply Card*

Valves for Boiler Services

Everlasting Boiler Service Valves, Bulletin E125; 22 pages of complete catalog information on quick-opening and slow-opening straightway valves, angle valves, "Y" valves, and blow-off units; including valves for fire protection. Everlasting Valve Co., Dept. 38, 49 Fisk St., Jersey City 5, N. J.

Circle No. **16** *on Reply Card*

Drum Cleaning Technique

Pangborn Rotoblast Drum Cleaning Machines, Bulletin No. 220; six pages covering a technique for cleaning drums and covers by hurling metallic abrasives against drum surfaces by centrifugal force; one unit having a capacity of 70 drums/hr., the other 140/hr. Pangborn Corp., Hagerstown, Md.

Circle No. **17** *on Reply Card*

Heat Transfer Tube and Plate

Anaconda Tubes and Plates for Condensers and Heat Exchangers, Publication B-2; 44-page booklet discussing application and installation of condenser and heat exchanger tubes, also plates for tube sheets, heads and baffles; including data on operational factors affecting tube life and corrosion factors in tube service. American Brass Co., Waterbury 20, Conn.

Circle No. **18** *on Reply Card*

Conductivity and pH

pH and Conductivity Recorders and Controllers, Catalog 15-16; 40 pages on operating principles, measuring systems, details of components, and typical applications in field of pH, oxidation-reduction potential, and electrolytic conductivity. Minneapolis-Honeywell Regulator Co., Brown In-

Depend on

AUTO-LITE

FOR TEMPERATURE INDICATION

Auto-Lite Thermometers are designed to give you the broadest selection for your needs: Priced low and precision-made for accuracy, these instruments point the way to temperature savings and help to prevent spoilage. Write for catalog showing the many styles and types of Auto-Lite Thermometers that are available.

FOR APPLICATIONS IN
NATURAL GASOLINE & CYCLING PLANTS, PUMPING STATIONS, REFINERIES, ETC.

Illustrated, at top: Model G Indicating Thermometer, flush mounting type with capillary tubing for remote reading. Priced from $18. At bottom: Model V Thermometer (vapor pressure type). Rigid stem for direct mounting. Priced from $10.25.

THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION, DEPT. O-8
TOLEDO 1, OHIO
NEW YORK • CHICAGO • SARNIA, ONTARIO

INDICATING & RECORDING THERMOMETERS

GOOD FOR ALL PRESSURES

Yarway Impulse Steam Traps are suitable for any pressure up to specified maximum *without change of valve or seat.* Types available up to 1500 lbs. Simplifies installation and maintenance. Over 650,000 Yarway Traps already *proved on the job.* Sold by over 200 distributors. Bulletin T—1740 free.

YARNALL-WARING CO. 153 MERMAID AVENUE, PHILA. 18, PA.

(To obtain more data on advertised products see page 1292)

struments Div., Wayne & Windrim Aves., Philadelphia 44, Penna.

Circle No. **19** *on Reply Card*

Nickel Alloyed Cast Irons

Engineering Properties and Applications of Ni-Resist, 3rd Ed., 36 pages on eight types of austenitic nickel alloy cast irons; applications and comparative service data; table of properties; and including corrosion information on nearly 400 conditions. International Nickel, Dept. EZ, New York 5, N. Y.

Circle No. **20** *on Reply Card*

Portable Visbreaker Heater

Lummus Beats the Clock for Magnolia, 16 pages describing the design and construction of a 900-ton portable visbreaker heater for Magnolia Petroleum Co. at Beaumont, Texas. The Lummus Co., 385 Madison Ave., New York 17, N. Y.

Circle No. **21** *on Reply Card*

Plate Fabrication

Steel and Alloy Plate Fabrication; an eight-page bulletin describing the company's engineering and fabricating facilities for a wide variety of tanks, towers, reactors, and similar vessels for the process industries. Colonial Iron Works Co., 17631 St. Clair Ave., Cleveland 10, Ohio.

Circle No. **22** *on Reply Card*

Long Distance Transmitters

Builders Chronoflo Telemeters, Bulletin 230-H4; eight pages covering an instrument system that provides transmission of information and controls over a simple two-wire electrical circuit for unlimited distances; with photos and diagrams explaining the mechanism and installations on metering and control of flow, liquid level, pressure and temperature. Builders-Providence, Inc., 447 Harris Ave., Providence 1, R. I.

Circle No. **23** *on Reply Card*

Sealing Compounds

Parker Thread Sealing and Valve Lubricant Compounds, Catalog 5400; describes 12 different materials including general purpose thread and gasket sealing and anti-seize compounds as well as specialized mixtures for service with aluminum parts, and for alcohol, oxygen, and fuel handling systems. Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle No. **24** *on Reply Card*

Explosion-proof Motors

Safe U. S. Motors, Form 1629; eight pages in color describing a line of totally-enclosed, explosion-proof electrical motors, from ¼ to 75 hp., for use in dusty, damp, or hazardous locations. U. S. Electrical Motors, Inc., P. O. Box 2058, Los Angeles 54, Calif.

Circle No. **25** *on Reply Card*

Tube Fittings

Swagelok Tube Fittings, Catalog B-151; 12 pages on a complete line of leakproof fittings in brass, aluminum, steel, stainless steel, and Monel for process or instrument lines; with dimensional information, cross section drawings, installation recommendations, and assembly instructions. Crawford Fitting Co., 884 East 140th St., Cleveland 10, Ohio.

Circle No. **26** *on Reply Card*

Force Balance Control

Nullmatic Controllers, Bulletin 5011, 16 pages describing fundamentals of operation and use of pneumatic force balance type controllers, "M/P" Control Stations, and Derivative Units; including a complete summary of performance data on each instrument. Moore Products Co., H & Lycoming Sts., Philadelphia 24, Penna.

Circle No. **27** *on Reply Card*

TANK CAR INTERIORS

cleaned faster to speed up turnaround

SEND for this FREE Booklet. It is full of useful information on general maintenance cleaning. Covers all divisions of the Petroleum Industry—production, processing, transportation, marketing.

WITH the Oakite Interior Tank Cleaner you can count on much greater availability of tank cars. This unit cuts tank car cleaning time 70%. It eliminates manual brushing, scraping and steaming-out. With this completely automatic cleaning unit you can condition light-oil carriers in ½ to 1 hour. Crude, creosote or asphalt carriers take from 1 to 3 hours.

Contact your local Oakite Technical Service Representative for complete installation details on this scientifically designed mechanical spray-detergent cleaning method. Or write Oakite Products, Inc., 44C Thames Street, New York 6, New York for illustrated folder F-7679.

Technical Service Representatives in Principal Cities of U. S. & Canada

OAKITE

TRADE MARK REG. U. S. PAT. OFF.

SPECIALIZED INDUSTRIAL CLEANING
MATERIALS • METHODS • SERVICE

(To obtain more data on advertised products see page 1292)

SHIPMENT = SAMPLE

You can be sure of uniform shipments of W. C. Hardesty Co., Inc. Fatty Acids because . . . Hardesty's production in its own modern plants is "Standardized" to deliver every shipment exactly . . . as per sample.

RED OIL · WHITE OLEINE · STEARIC ACID
HYDROGENATED FATTY ACIDS · ANIMAL & VEGETABLE FATTY ACIDS
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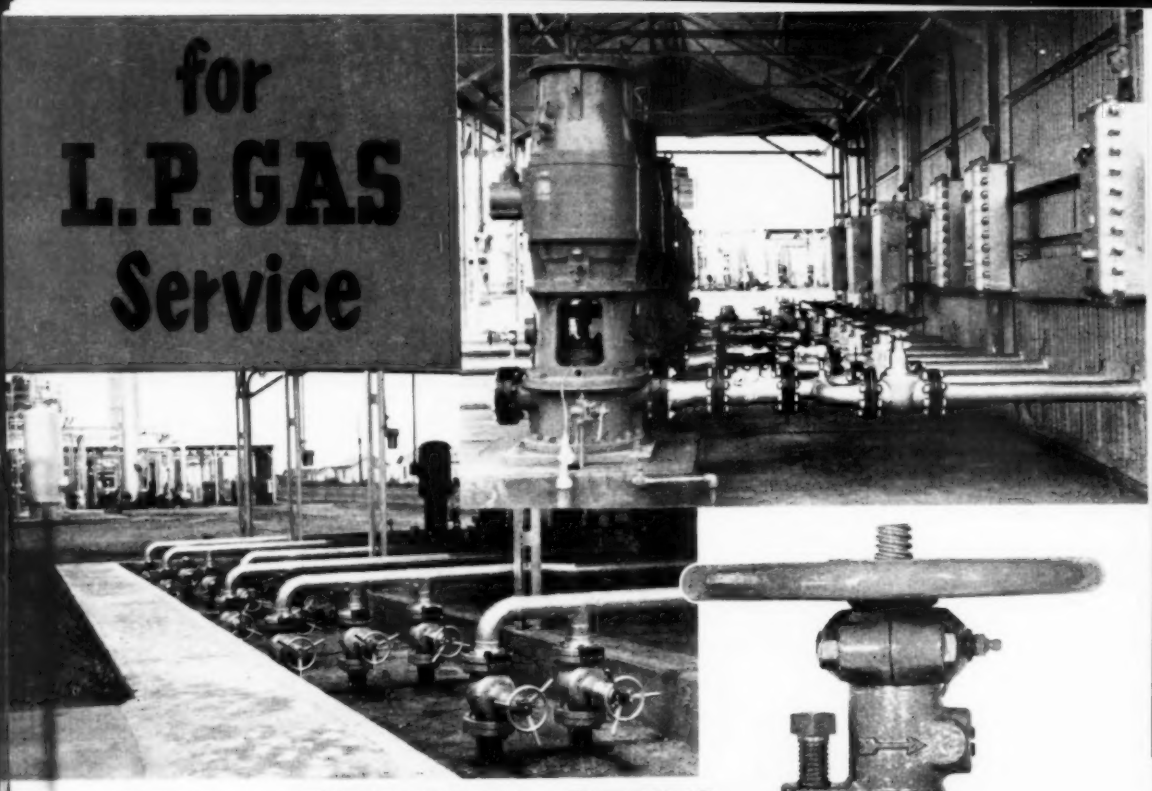
41 EAST 42nd STREET, NEW YORK 17, N. Y.

PLANT: DOVER, OHIO · IN CANADA: W. C. Hardesty Co. of Canada, Ltd., Toronto

for L.P. GAS Service



ORBIT VALVES ®

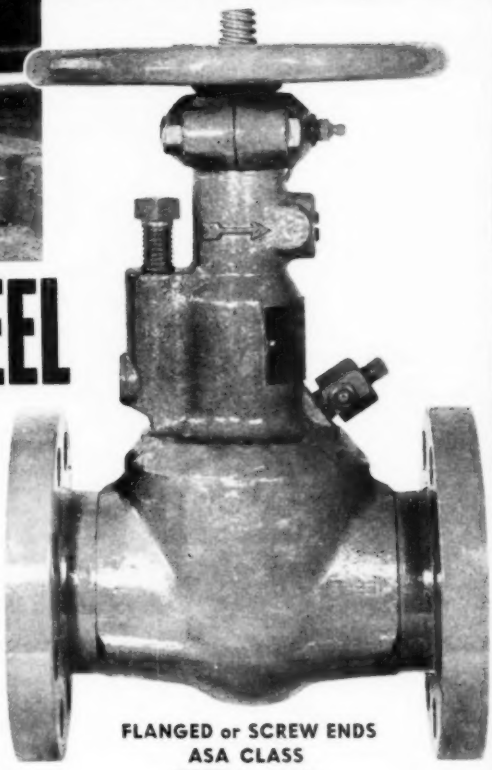
FORGED STEEL

If you are planning new plant construction or to replace valves in a plant already on stream then is the time to specify Orbit Forged Steel LP Gas Valves.

Orbit LP Gas Valves feature an all Forged Body and Bonnet plus welded bonnet construction and adjustable reliable plastic stem packing—this combination makes the Orbit LP Gas Valve the "last word" in safety and dependability.

Orbit LP Gas Valves require no lubricant to effect a shut-off. Orbit's Friction Free resilient seating principle gives further insurance against products contamination and loss through vapor leaks.

Anyone who has tried this Valve or those who are now using it are satisfied customers.



FLANGED or SCREW ENDS
ASA CLASS
SIZES 1" to 4"

SOLD BY SUPPLY STORES

ORBIT VALVE CO.

P. O. BOX 699 — **TULSA, OKLAHOMA**

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HOUSTON, TEXAS
407 Velasco
(Serving the Gulf Coast)

ODESSA, TEXAS
Starr Warehouse
(Serving West Texas)

CASPER, WYOMING
The Great Western Co.
(Serving the Rocky Mountain States and Canada)

"Benturi" Fractionator Trays

Another Important Development by Koch; four pages covering a new design in "Kaskade" trays with a minimum pressure drop per theoretical tray; the vapor riser of which is in the shape of a bent venturi and approaches the characteristics of a venturi to within ±2%. Koch Engrg. Co., Inc., 321 West Douglas, Wichita 2, Kans.

Circle No. **28** *on Reply Card*

Portable Fire Fighting Tower

Easy to Reach, a four-page folder describing a new foam tower or applicator with easy mobility over rough terrain and fast erection with a minimum number of men; for delivery of foam to tanks up to 50 ft. in height. Pyrene Mfg. Co., 560 Belmont Ave., Newark 8, N. J.

Circle No. **29** *on Reply Card*

Analysis of Alkalies

The Analysis of Alkalies, Technical & Engineering Service Bulletin No. 9, revised; 72 pages of text, tables, and charts, including recalculation of analytical factors to the basis of the 1948 International Atomic Weights, a colorimetric test for iron and copper, and a temperature correction table for volumetric solutions. Solvay Sales Div., Advtg. & Sales Promotion Dept., Allied Chemical & Die Corp., 40 Rector St., New York 6, N. Y.

Circle No. **30** *on Reply Card*

Construction Jacks

Duff-Norton Oil-Field Jacks, Bulletin AD-19, four pages of catalog information on a line of mechanical and hydraulic jacks suitable for lifting and lowering, rigging jobs, setting heavy equipment, etc. in both refineries and oil production work. Duff-Norton Mfg. Co., Pittsburgh 30, Penna.

Circle No. **31** *on Reply Card*

Variable Area Flow Meters

Brooks Rotameters, Bulletin 110; gives catalog data on a complete line of variable area type meters for virtually every application from small flow indication to high capacity, high pressure meters as well as research and test kit models. Brooks Rotameter Co., Dept. LJ, Box 432, Lansdale, Penna.

Circle No. **32** *on Reply Card*

Stabilized pH Indicator

Stabilized L&N pH Indicator, Folder EM9-96(1); eight pages on a new converter-type instrument requiring no range changing, with reading accuracy to ±0.02 pH, unaffected by normal fluctuations in line voltage or by zero drift of the amplifier. Leeds & Northrup Co., Philadelphia 44, Penna.

Circle No. **33** *on Reply Card*

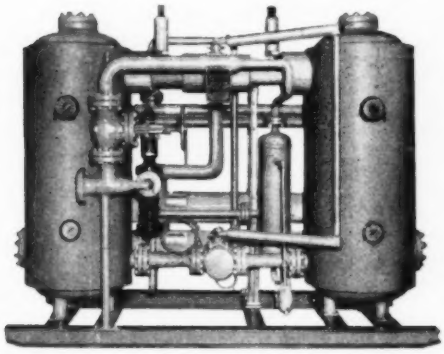
Control Equipment, Valves, etc.

Climax Controls, approximately 175 pages of complete catalog information on company's entire line; including diaphragm control valves, pressure regulators, level controllers, flow controllers, safety valves, relief valves, strainers, traps, governors; and also a section on capacity charts and engineering data. Black, Sivalls & Bryson, Inc., Climax Controls Div., 15 N. Cincinnati, Tulsa 1, Okla.

Circle No. **34** *on Reply Card*

Stop Those Hammering Lines

Water Hammer—Cause, Effect and Control in Piping Systems, bulletin WH-851; 8-page booklet describes water hammer in non-technical terms; indicates its potential damage to piping, instruments and other parts of water systems; discusses application of Williams-Hager Silent Check Valve



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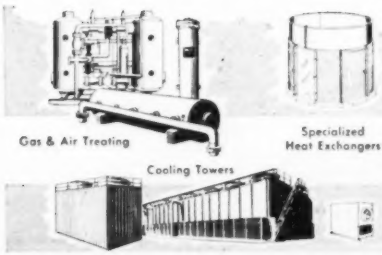
FOR DEPENDABLE
DEHYDRATION!

The Pritchard HYDRYER*

The Pritchard HYDRYER* is *unexcelled* for dependable dehydration of air and other gases for instrument and process controls. Dual adsorbers provide continuous drying action. Standard packaged units designed to reduce dew points to minus (—)40°F. Only service connections are required. Specially designed HYDRYER* units can be tailored to your individual requirements.

*Registered Trade Name



Write Today for Bulletin No. 16.0.080

Producers of QUALITY Specialized Process EQUIPMENT

J.F. Pritchard & Co.

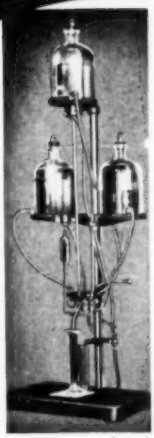
EQUIPMENT DIVISION

Dept. No. 187 — 908 Grand Ave., Kansas City 6, Mo.

District Offices: CHICAGO • HOUSTON • NEW YORK • PITTSBURGH
TULSA • ST. LOUIS • Representatives in Principal Cities from Coast to Coast

(To obtain more data on advertised products see page 1292)

SULFUR and CARBON
Analyses
in
PETROLEUM PRODUCTS



The sulfur content of oils, waxes and greases is an important measure of the value and quality of the product.

Whether the desired sulfur content be high or low, it is necessary to know exactly what amount is present.

The combustion method offers a rapid and sure means of determining sulfur in the wide range of percentages and materials encountered in the oil and grease field.

The Dietert-Detroit Sulfur Determinator embodies the correct principles of the combustion method in a simple, rugged and convenient form. Complete analysis can be made in less than five minutes.

Carbon determinations on organic compounds are being made in as little as two minutes with the Dietert-Detroit No. 3003 Carbon Determinator.

This method can be applied to any petroleum product. One example of the usefulness of this method is the analysis of cracking catalyst for carbon content.

Leading oil companies* are taking advantage of these versatile, time-saving determinators. Write to Dept. P-3 for detailed information on how you can apply rapid carbon and sulfur analysis to your problems.

*Two typical users— THE SHELL OIL COMPANY / THE PURE OIL COMPANY

CONTROL EQUIPMENT
HARRY W. DIETERT COMPANY
9330 ROSELAWN • DETROIT 4, MICH.

What's New!

to control it. Williams Gauge Co., 1620 Pennsylvania Ave., Pittsburgh 33, Pa.

Circle No. **35** *on Reply Card*

Ultrasonic Testing Services

Sperry Commercial Testing Services, Bulletin 50-115; describes a service offered industrial concerns with an occasional need for ultrasonic, nondestructive testing of metals and other materials with the Reflectoscope and/or Reflectogage, or both. Sperry Products, Inc., Danbury, Conn.

Circle No. **36** *on Reply Card*

Process Instruments

Instrumentation, Vol. 5, No. 4; includes special articles on 1) a new color type graphic panel at Imperial Oil Ltd.'s Winnipeg refinery; 2) a line of remote controller; 3) proper lubrication of valves; and 4) electronic integration. Minneapolis-Honeywell Regulator Co., Industrial Div., Philadelphia 44, Penna.

Circle No. **37** *on Reply Card*

Steam Plant Instruments

Yarway Water Columns and Gages, Bulletin WG-1811; 28 pages covering this type of equipment; including information on flat-glass inserts for high-pressure gages, illuminators, and the like. Yarnall-Waring Co., Mermaid Lane, Philadelphia 18, Penna.

Circle No. **38** *on Reply Card*

For Your Convenience

Business reply cards are included in each issue of PETROLEUM PROCESSING to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing the first page of this section. Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the bottom of the card and drop it in the mail. No postage required.

Literature Offered in this Issue's Advertisements

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature offered in this issue:

ADDITIVES, for cutting oils: Information on Santolube 32. See adv't p. 1193.

ALLOYS, aluminum bronze: Information. See adv't pp. 1222-1223.

ALUMINA, activated: Information. See adv't p. 1219.

ANALYZERS, for sulfur and carbon in petroleum: Detailed Information: See adv't p. 1302.

ANTI-KNOCK: TEL Blending Chart. See adv't facing pp. 1228-1229.

CHEMICALS, organic: Bulletin 100. See adv't p. 1225.

CLEANING, maintenance: Booklet. See adv't p. 1209.

COMBUSTION UNITS, for vertical furnaces: Literature. See adv't p. 1278.

COMPRESSORS, centrifugal: Bulletin. See adv't p. 1228.

CONTROLLER, force-balance, single knob adjustment: Bulletin. See adv't pp. 1202-1203.

CONTROL SYSTEM, for process & power instrumentation: Literature. See adv't p. 1279.

COOLING TOWERS: Bulletin. See adv't p. 1270.

CORROSION, high temperature: Work Sheet. See adv't p. 1280.

DEHYDRATION, for instrument air and other gases: Bulletin No. 16.0.080. See adv't p. 1282.

EXPANSION JOINTS: 24-page Catalog. See adv't p. 1195.

FANS, cooling tower: Information. See adv't p. 1189.

FITTINGS & FLANGES, pipe: Data Sheet. See adv't p. 1305.

FITTINGS, welded: Catalog. See adv't p. 1218.

GENERATORS, steam, bent tube: Bulletins. See adv't p. 1201.

HEAT EXCHANGERS, sectional hairpin: Bulletin No. 481. See adv't p. 1204.

HEATER, deaerating: Complete Information. See adv't p. 1207.

HOSE, marine & barge: Complete Catalog. See adv't p. 1300.

JACKETING, aluminum: Free Sample. See adv't p. 1195.

MIST ELIMINATOR: 8-page Brochure. See adv't p. 1306.

PAINT, plastic corrosion-resistant: Bulletin 720. See adv't p. 1284.

PUMPS, centrifugal, for boiler feed service: Information. See adv't p. 1263.

PUMPS, vertical centrifugal: Bulletin B-592-1. See adv't p. 1221.

PURIFIER, screw connections: Bulletin #500. See adv't p. 1205.

STEAM TRAPS: Bulletin T-1740. See adv't p. 1296.

STEAM TRAPS: Catalog 751. See adv't p. 1273.

TELEVISION, industrial: Bulletin 1025B. See adv't p. 1217.

THERMOMETERS: Catalog. See adv't p. 1297.

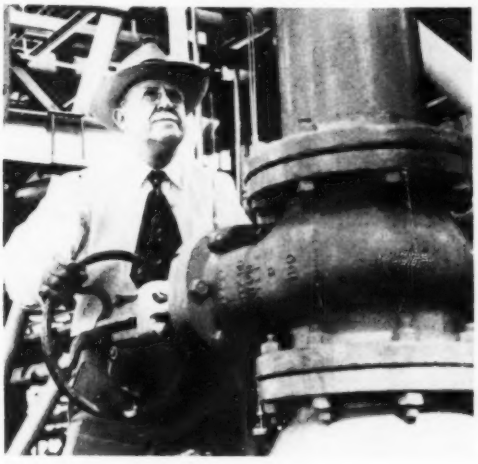
TUBE CLEANERS & EXPANDERS: Details. See adv't p. 1285.

VALVES: New Catalog. See adv't p. 1206.

VALVES, control, diaphragm type: Bulletin 750. See adv't p. 1267.

WAX MOULDING, continuous: Bulletin. See adv't p. 1182.

Gulf Veteran Starts Giant Cracker



Charles R. Stevenson, manager of Gulf Oil Corp.'s Port Arthur plant and employe with the longest service, turns the valve that sends the initial charge stock into a new 60,000 b/d fluid catalytic cracker at Port Arthur. Mr. Stevenson accorded the honor of "christening" the unit because of his service record. He has been with the 50-year-old company for 49½ years.

A. L. Lyman, vice president and director of laboratories for California Research Corp., has been named chairman-elect for the petroleum chemistry division of the American Chemical Society. He will serve in this capacity until next September, when he will succeed **F. E. Frey,** asst. director of research for Phillips Petroleum Co., present chairman of the division.

Mr. Lyman

Mr. Frey

W. F. Faragher, research and development department head for Houdry Process Corp., continues as division secretary.

* * *

Dr. W. E. Bradley has been named manager of research of Union Oil Co. of California and will run the company's new $8,000,000 research laboratories nearing completion at Brea, Calif. Dr. Bradley has been assistant to the vice president in charge of research. Other major staff appointments:

Homer Reed, chief engineer for manufacturing, will be chief engineer in charge of engineering and development.

R. J. Garofalo, assistant patent counsel, becomes patent counsel.

J. E. Sherborne, formerly assistant to the vice president, will be assistant manager of research.

Dr. Clyde Berg, assistant to the research vice president, to be manager of process development, at the Los Angeles refinery.

Arnold Kelley becomes supervisor of manufacturing processes at the Los Angeles office.

Jack Tielrooy will be supervisor of chemical processes at Brea.

Paul Foreman will be supervisor of process economics at Brea.

* * *

Chalmer Gatlin Kirkbride, vice-president and director of Houdry Process Corp., has been chosen to receive the 1951 Professional Progress Award in Chemical Engineering, sponsored by Celanese Corp. of America. The award which carries with it a prize of $1,000, is administered by the American Institute of Chemical engineers, and will be given at the organization's Annual Meeting this December at Atlantic City.

Mr. Kirkbride

The Celanese award winner is a graduate in chemical engineering with a degree of M.S. in chemical engineering from the University of Michigan, and has been with the Standard Oil Co., Ind., assistant director of research with Pan American Refining Corp., chief of chemical engineering development, Magnolia Petroleum Co., and professor of chemical engineering at Texas A. & M.

* * *

The National Production Authority, U. S. Department of Commerce, has announced the appointment of **Osgood V. Tracy** as Deputy Director of NPA's Chemical Division. He is on leave as general manager of the chemical products department of Esso Standard Oil Co. He was formerly operations head of Standard Oil Development Co., the central technical organization of Standard Oil Co. (N. J.) affiliates, and manufacturing coordinator of chemical products for Esso Standard.

Mr. Tracy

Mr. Tracy graduated from the United States Naval Academy in 1924. After duty with the Navy, he entered the chemical field with the Solvay Process Co. in 1926. In 1930 he joined the Standard Oil Co. (N. J.) at Baton Rouge, La.

* * *

Recent additons to the technical staff of the Whiting Research Laboratories of Standard Oil Co. (Ind.) include the following:

Ralph J. Bertolacini, M.S. chemist from Michigan State College; **Jarvis B. Beverly,** chemistry graduate from the University of Texas and recently associated with Shell Oil Co.; **Cecil G. Brannen,** Ph. D. in chemistry from Iowa State College; **Robert L. Chilenskas,** graduate in chemical engineering from the University of Illinois and recently associated with Monsanto Chemical Co.

Donald R. Coughanowr, M.S. chemical engineer from the University of Pennsylvania; **Lowell T. Crews,** M.S. chemist from Oklahoma A. & M. College and recently associated with The Toni Co.; **Robert H. Crowther,** M.S. chemical engineer from Kansas State College; **Kenneth L. Dudek,** M.S. chemical engineer from Northwestern University; **Edward B. Eriksen,** M.S. chemical engineer from the University of Michigan.

John B. Malloy, M.S. chemical engineer from Massachusetts Institute of Technology; **Basil P. Mann,** M.S. chemical engineer from Illinois Institute of Technology; **Lawrence C. Mohr,** graduate in chemical engineering from Illinois Institute of Technology and recently associated with

the Hills-McCanna Co.; **Jack Oita,** M.S. chemist from the University of Nebraska.

William F. Pansing, Ph. D. in chemical engineering from the University of Cincinnati; **Eugene E. Richardson,** Ph. D. in chemistry from Kansas State College; **Alvin W. Ries,** graduate in chemical engineering from Cornell University; **Betty Ellen Ries,** M.S. chemist from Cornell University; **Bruce A. Ritzenthaler,** graduate in physics from Illinois Institute of Technology and recently associated with the Illinois Testing Laboratories.

Paul N. Rylander, Ph. D. in chemistry from Indiana University and recently engaged in post-doctorate research at Harvard; **John Sanik, Jr.,** Ph. D. in chemistry from Kansas State College; **Walter D. Schmidt,** graduate in chemical engineering from The Johns Hopkins University and recently associated with the Armour Research Foundation; **Robert D. Sieron,** M.S. chemical engineer from the University of Notre Dame; **Dean R. Smith, Jr.,** graduate in chemical engineering from the University of Michigan.

John P. Soderberg, M.S. chemical engineer from the University of Michigan; **Edward A. Swakon,** D.Sc. in chemistry from Carnegie Institute of Technology; **Robert H. Wise,** M.A. chemist from the University of Missouri; and **Samuel Young, Jr.,** M.S. chemical engineer from the University of Michigan and recently associated with Cities Service Oil Co.

* * *

Arthur C. Pabst, asst. supervisor of processes and products research at the technical service department, Socony-Vacuum Laboratories, Brooklyn, has been selected by the company for a year's post-graduate work at Harvard University's School of Public Health, Boston.

Mr. Pabst

His studies there will lead to a master's degree in industrial hygiene. After obtaining his degree he will join the staff of Socony-Vacuum's medical department in New York, where he will assist in matters pertaining to health conditions in refineries and other company operations.

Mr. Pabst, who already holds a master of chemical engineering degree from Brooklyn Polytechnic Institute, joined Socony-Vacuum 20 years ago as a chemist.

* * *

Gordon R. Henderson, former chief engineer of the Polymer Corp., Sarnia, Ontario, has been appointed general manager of its Canadian activities.

Mr. Henderson

Mr. Henderson received his bachelor of science degree with honors in civil engineering from Queen's University at Kingston, Ontario, in 1925.

He served a two-year student apprenticeship with the Ontario Hydro-Electric Power Commission, subsequently working in various engineering capacities with Dominion Engineering Works, Ltd., and Power Corporation of Canada, Ltd., both of Montreal.

In 1932 he joined the engineering staff of Shell Oil Co. of Canada, at its Montreal refinery, becoming chief engineer of that plant in 1936.

Mr. Henderson remained at Montreal until 1940 when he was given charge of the construction of an $18.-

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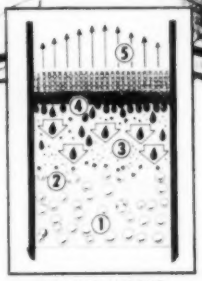

HOW IT WORKS

(1) Gas passes through liquid. (2) Bursting gas bubbles produce fine spray of liquid droplets. (3) Droplets are entrained in rising stream. (4) Droplets coalesce on knitted-wire surfaces to form large drops that fall back against the flow. (5) Gas passes on, freed from entrainment. The liquid is returned.

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000,000 Shell Oil refinery at Heysham Lanes, England. In 1942 he became chief engineer of that refinery.

* * *

The Standard Oil Development Co. has established a department of public relations and has appointed **C. E. Starr, Jr.** as manager. Since 1945, Mr. Starr has been an assistant director of the Esso Laboratories at the Baton Rouge Refinery.

Mr. Starr

To fill the vacancy created by Mr. Starr's promotion, **Mr. J. E. Moise** has been appointed assistant director.

Mr. Moise

Mr. Starr attended Miami University and was graduated from M.I.T. with the degree of Bachelor of Science in chemical engineering in 1931. Following graduation he returned to Miami University as an instructor. He was employed by the duPont Co. during the period 1933 to 1936. In 1936 he was employed as a chemical engineer by the Esso Laboratories of Esso Standard Oil Co. at Baton Rouge, La. In 1945 he became assistant director of the Esso Laboratories at Baton Rouge, which position he has held until his appointment as public relations manager for the Standard Oil Development Co.

Mr. Moise attended Tulane University, from which he graduated in 1933 with the degree of Bachelor of Science in chemical engineering. In 1933 he was employed as a chemical engineer at the Baton Rouge Esso Laboratories. He has been on the laboratories' staff continuously since that time; and he has progressed, through assignments of increasing responsibility, to his present promotion as an assistant director.

* * *

Joseph J. Pinos, with Standard Oil Co. (Ohio) for 20 years, safety engineer at Cleveland No. 1 refinery the last ten years, has resigned to join American-La France Foamite Co. as a sales representative in the Cleveland territory.

* * *

Dr. M. E. Spaght, president of the Shell Development Corp., Emeryville, Calif., has been elected to the board of the Stanford Research Institute.

Six additions to the Shell staff at Emeryville, Calif. are:

Ernest G. Holzmann, formerly research assistant in acoustics at M.I.T. where he obtained a M.S. and graduate of University College, Nottingham, England.

William B. Humble, electrical engineer who has been active in power engineering and consultant work in San Francisco.

Mary Neal, analytical chemist, formerly research assistant in biochemistry at Northwestern.

Lloyd F. Freechtle, M. S. at University of California; **Richard W. Kunstman,** Ph. D. candidate at University of Illinois, and **Harry A. Wistrich, Jr.,** Ph. D. at Cornell, all chemical engineers.

* * *

F. M. Simpson has been elected president of Cit-Con Oil Corp., Lake Charles, La. He succeeds **Burl S. Watson,** who became chairman of the executive committee. Mr. Simpson has been vice president and general manager of Cit-Con since its organization in 1947.

He joined Cities Service upon his graduation from Texas A & M College, and held various positions in the organization prior to his association with Cit-Con.

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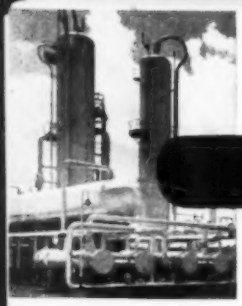

EDITORIAL VIEWPOINTS

Opinions and Comments on Current Topics

Caution on Petrochemicals

THE outlook for the growth of the petrochemical industry is little short of amazing. As competent an authority as Dr. Wayne E. Kuhn, Manager of the Technical and Research Division, The Texas Co., has stated that, 10 years hence, the capital investment in petrochemical plants in the U. S. may reach $8,000,000,000. Their product output may be around 65,000,000,000 pounds annually, about 50% of all chemicals manufactured here. The magnitude of this possible investment is indicated from the fact that the present capital investment in petroleum refineries in the U. S. is not over $5,000,000,000 before depreciation. Of course, the dollar yardstick, in terms of tangibles, is entirely different in the two cases.

The possible enthusiasm engendered by an output figure running into ten or eleven digits can be tempered by comparing this estimated output of petrochemicals a decade hence with present volumes of petroleum products. On the basis of 8 pounds of chemicals to a gallon and 42 gallons to the oil industry's barrel, the total of 65,000,000,000 pounds is reduced to around 193,500,000-bbls. This would be about one-fifth of the refinery output of gasoline in 1950. A very small proportion of our petroleum supplies, diverted to this field, would more than meet market demands for many chemicals.

Authorities in the petrochemical industry emphasize the conditions in its development which differ greatly from those experienced with petroleum refining enterprises. Capital investment requirements may be three times or more those required in petroleum refining on a per barrel basis. Utility requirements will be considerably greater, on a per barrel of charge stock basis. Greater competitive advantages costwise are seen for large plants over small plants in many cases. Geographical location will be more important, since freight rates on chemical products are much higher than on the standard petroleum products. Technical and economic research will be important, and likely more costly than in the petroleum refining field. Successful participation in this coming development by the individual company, large or small, will require correctly resolving these and other factors in terms of the individual proposal. Experience in refining petroleum of itself will not be a safe guide in this new field. —V.B.G.

Improving Analytical Accuracy

THE California Natural Gasoline Assn. is to be commended for its technical program designed to promote greater accuracy in the fractional analysis of natural gasoline liquids. CNGA's Technical Committee reported to the 26th annual fall meeting of the association that samples of commonly encountered light hydrocarbon mixtures are being sent to cooperating laboratories for fractional analysis by the methods commonly used there. The reports from the individual laboratories are then analyzed and correlated against the true composition of the sample mixtures.

Such a program as the CNGA has embarked upon can have great value in plant operations through the improving of laboratory techniques. The efficiency of operating unit cannot readily be evaluated without accurate knowledge of feed streams, reflux, bottom and sidecut products compositions. Accurate product compositions have importance for the plant's customers also. A similar technical activity has been carried on by natural gasoline plant companies in the Mid-Continent and Southwest through the Natural Gasoline Assn. of America. The coordinating work on which the CNGA is now embarked will enhance the value of the work to both groups and to the natural gasoline industry as a whole. —D.P.T.

Sulfur, the Common Enemy

THE problem of removing the various types of sulfur compounds present in crude petroleum, or of converting existing types to others less objectionable, is not a new one to refiners. It is becoming progressively more severe, however, as more crudes with high sulfur content are processed, and as more complicated and costly refining processes are installed. Also, the effectiveness of tetraethyl lead as an antiknock agent is greatly decreased by sulfur in gasoline.

An additional present factor of some economic importance is the shortage of sulfur, which serves to stimulate the search for improved methods of sulfur removal and recovery. A paper on desulfurization and sweetening presented by an Anglo-Iranian Oil Co. technologist before the recent meeting of the ACS Petroleum Chemistry Division in New York placed the tonnage of sulfur in crude petroleum produced in North America, including Canada and New Mexico, at 2,600,000 long tons per year. This is half the approximately 5,200,000 long tons of native sulfur mined in the U. S. in 1950.

In view of these factors it is certain that the search to find better methods for removing sulfur from crude, petroleum products and gases will remain a live research project in coming years. Where consumer interests are insistent the effort will continue to eliminate sulfur from finished products. It is already reaching into a field of improving cracking catalysts to give them greater stability where sulfur charge stocks are handled. An important fundamental study now under way is the identification of the different types of sulfur compounds occurring in crude oil and of the behavior of these compounds in processing operations. This work is being done by the U. S. Bureau of Mines at Bartlesville, Okla., as API Research Project 48. In view of the common interest in sulfur removal it would be in the interests of the refining industry if this work could be intensified. —V.B.G.

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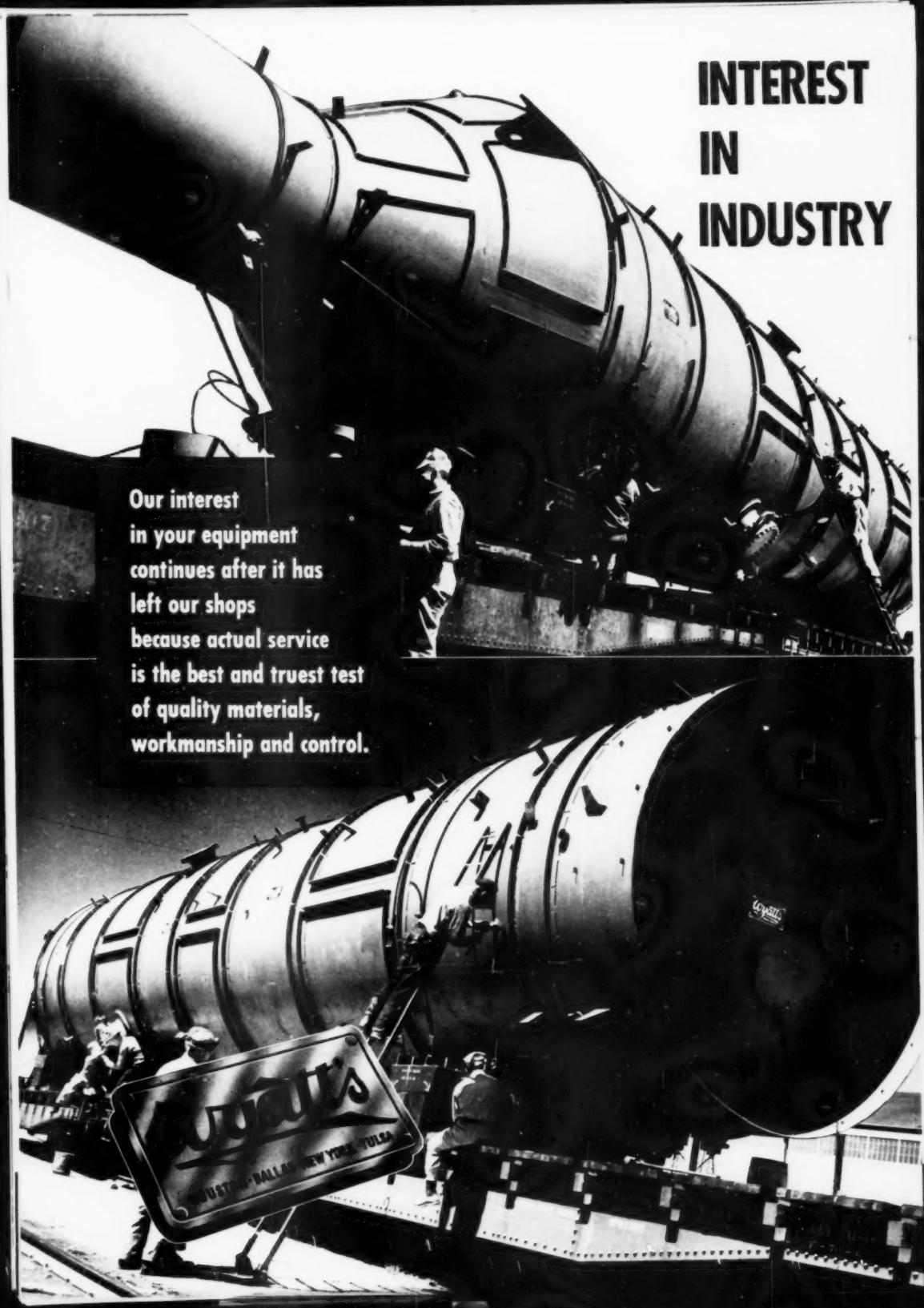
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